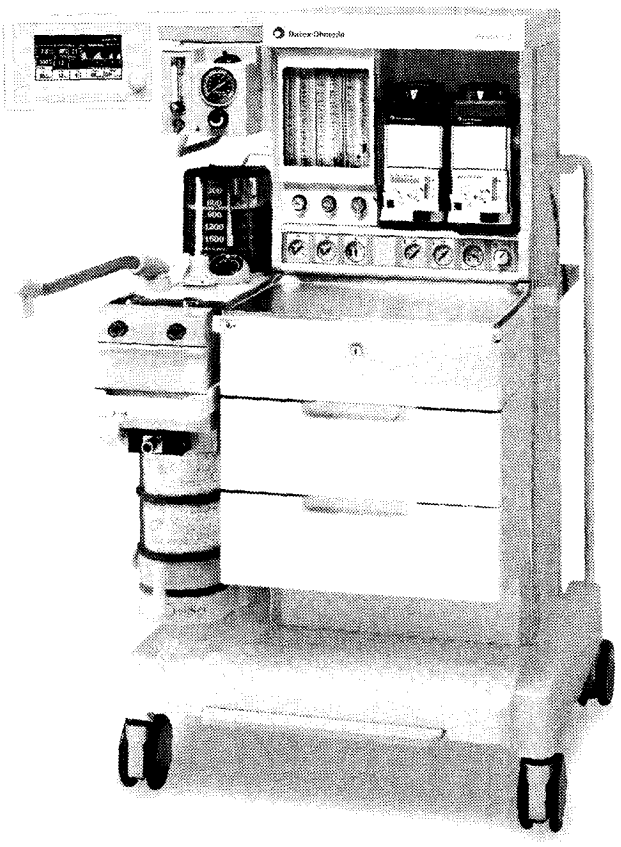
Aestiva

Operation Manual—Part 2

Software Revision 3.X

Setup, Cleaning and Sterilization, Maintenance and Troubleshooting



Datex·Ohmeda

Devoted to caring for life

This Product will perform in conformity with the description thereof contained in this operating manual and accompanying labels and/or inserts, when assembled, operated, maintained, and repaired in accordance with the instructions provided. This Product must be checked periodically. A defective Product should not be used. Parts that are broken, missing plainly worn, distorted, or contaminated should be replaced immediately. Should repair or replacement become necessary, Datex-Ohmeda recommends that a telephonic or written request for service advice be made to the nearest Datex-Ohmeda Field Service Support center. This Product or any of its parts should not be repaired other than in accordance with written instructions provided by Datex-Ohmeda and by Datex-Ohmeda trained personnel. The Product must not be altered without the prior written approval of Datex-Ohmeda's Quality Assurance Department. The user of this Product shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, improper repair, damage, or alteration by anyone other than Datex-Ohmeda.

⚠Caution U.S. Federal and Canadian law restrict this device to sale by or on the order of a licensed medical practitioner. Outside the U.S.A. and Canada, check local laws for any restriction that may apply.

Datex-Ohmeda products have unit serial numbers with coded logic which indicates a product group code, the year of manufacture and a sequential unit number for identification.

AAA A 12345

This alpha character indicates the year of product manufacture and when the serial number was assigned; "Y" = 1995, "Z" = 1996, "A" = 1997, etc. "I" and "O" are not used.

CE
0197

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Introduction

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How to use this manual

This is part two of the Aestiva operation and maintenance manual. It tells you how to:

- Remove and clean parts
- Set up the system
- Identify and replace worn or damaged parts
- Calibrate the O_2 sensor

The second half of this chapter is a maintenance schedule.

The last section, troubleshooting, tells you what causes each alarm and what you can do about it.

Use this manual together with part 1, which includes the operating instructions and preoperative checkout.

⚠ WARNING If an alarm occurs, safeguard the patient first, before troubleshooting or repair procedures.

Symbols used in the manual or on the equipment

⚠ Warnings and ⚠ Cautions tell you about dangerous conditions that can occur if you do not follow all instructions in this manual.

Warnings tell about a condition that can cause injury to the operator or the patient.

Cautions tell about a condition that can cause damage to the equipment. Read and follow all warnings and cautions.

Other symbols replace words on the equipment or in Datex-Ohmeda manuals. No one device or manual uses all of the symbols. These symbols include:

	On (power)	134°C	Not autoclavable
	Off (power)		Type B equipment
	Standby		Type BF equipment
	Standby or preparatory state for part of the equipment		Type CF equipment
	"ON" only for part of the equipment		Caution, ISO 7000-0434
	"OFF" only for part of the equipment		Attention, refer to product instructions, IEC 601-1
	Direct current		This way up
	Alternating current		Dangerous Voltage
	Protective earth ground		Input
	Earth ground		Output
	Frame or chassis ground	REF	Stock Number
	Alarm silence button	SN	Serial Number

	Equipotential
	Variability
	Variability in steps
+	Plus, positive polarity
-	Minus, negative polarity
	Lamp, lighting, illumination
	Movement in one direction
	Movement in two directions
	Lock
	Unlock
134°C	Autoclavable

CE XXXX	Systems with this mark agree with the European Council Directive (93/42/EEC) for Medical Devices when they are used as specified in their Operation and Maintenance Manuals. The xxxx is the certification number of the Notified Body used by Datex-Ohmeda's Quality Systems.
	Read top of float.
	Vacuum inlet
	Suction bottle outlet
O_2+	O2 Flush button
	Cylinder
	Isolation transformer
	Linkage system
	Risk of Explosion.
	Low pressure leak test

APL	Bag position/ manual ventilation
	Open drain (remove liquid)
Insp	Inspiratory flow
O_2%	O2 sensor connection.
< 345 kPa	The primary regulator is set to pressure less than 345 kPa
	CE European Union Representative

	Mechanical ventilation
	Close drain
Exp	Expiratory flow
	End case
< 414 kPa	The primary regulator is set to pressure less than 414 kPa.

Maintenance summary and schedule

These schedules show the minimum frequency. You will have to service the equipment more frequently if you use it:

- In unusual conditions (dirty gas supplies, high temperature, high humidity, etc.)
- More frequently than normal.

Operator maintenance

Examine all components and do the maintenance procedures more frequently if necessary.

Minimum Frequency	Maintenance
Daily	• Clean the external surfaces. • 21% O_2 calibration (circuit O_2 sensor). • Flow sensor calibration
Two weeks	• Drain the vaporizers and discard the agent. This is not necessary for Tec 6 vaporizers.
Monthly	• 100% O_2 calibration (circuit O_2 sensor). • Put Krytox (or a lubricant approved for use with 100% O_2) on all tee handle threads.
During cleaning and setup	• Inspect the parts for damage. Replace or repair as necessary
Annually	• Replace the external o-rings on the vaporizer ports.
As necessary	• Install new cylinder gaskets on cylinder yokes. • Replace the absorbent in the absorber. • Drain the breathing system. • Drain the breathing circuit module.[1] • Drain the overflow trap on the optional suction regulator. • Replace the circuit O_2 sensor. • Replace the disposable flow sensors (plastic)[2] • Replace the autoclavable flow sensors (metal)[3]. • Replace the receiver filter (active gas scavenging only).

1. This is included in the preoperative test procedure.
2. Under typical use the sensor meets specifications for 3 months
3. Under typical use the sensor meets specifications for 1 year.

Datex-Ohmeda approved service

Minimum Frequency	Maintenance
6 months	Have an approved service person do the service tests and scheduled service maintenance.

Cleaning and sterilization

⚠ **WARNING** Obey applicable safety precautions:

- Read the material data sheet for each cleaning agent.
- Read the operation and maintenance manual for all sterilization equipment.
- Wear gloves and safety glasses. A damaged O_2 sensor can leak and cause burns (contains potassium hydroxide).
- Do not breathe the fumes.

⚠ **CAUTION** To prevent damage:

- Refer to the manufacturer's data if you have questions about a cleaning agent.
- Do not use organic, halogenated, or petroleum based solvents, anesthetic agents, glass cleaners, acetone, or other harsh cleaning agents.
- Do not use abrasive cleaning agents (such as steel wool, silver polish or cleanser).
- Keep all electronic parts away from liquids.
- Do not permit liquid to go into the equipment housings.
- Do not soak synthetic rubber parts for more than 15 minutes. Swelling or faster aging can occur.
- Only autoclave parts that are marked 134°C.

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Summary

Patient path

The parts in Figure 2-1 send exhaled gas back to the patient. They may require more frequent cleaning/sterilization than parts in Figure 2-2. Refer to your hospital's infection control policy.

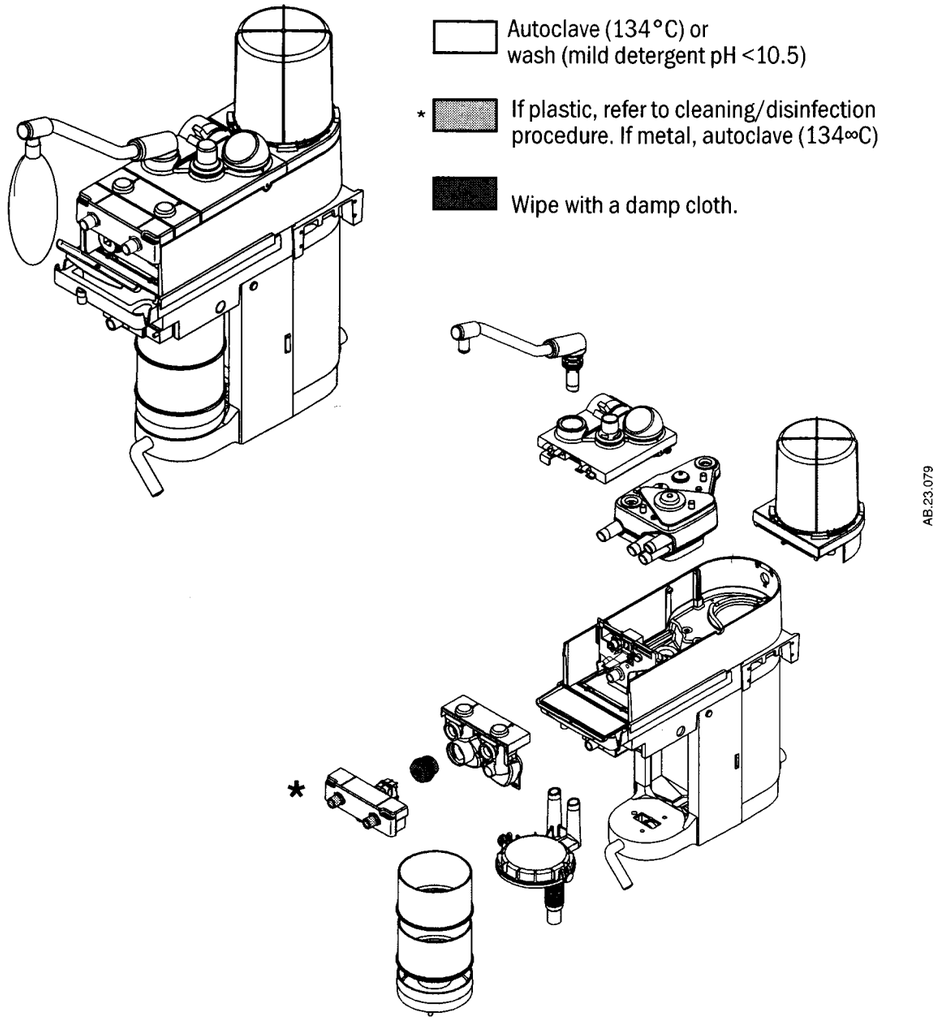

Autoclave (134°C) or
wash (mild detergent pH <10.5)
* If plastic, refer to cleaning/disinfection procedure. If metal, autoclave (134∞C)
Wipe with a damp cloth.
*
AB.23.079

Figure 2-1 • These parts return exhaled *gas to the patient*

Scavenging path

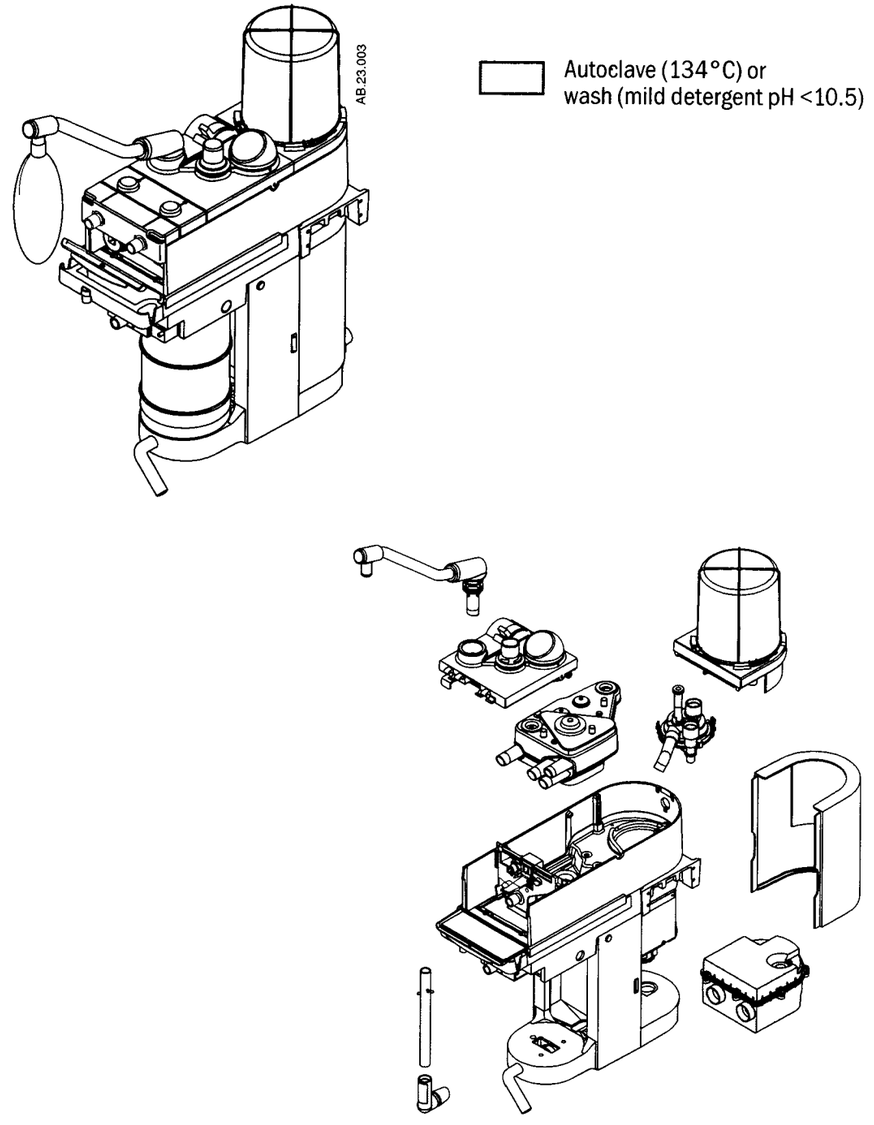


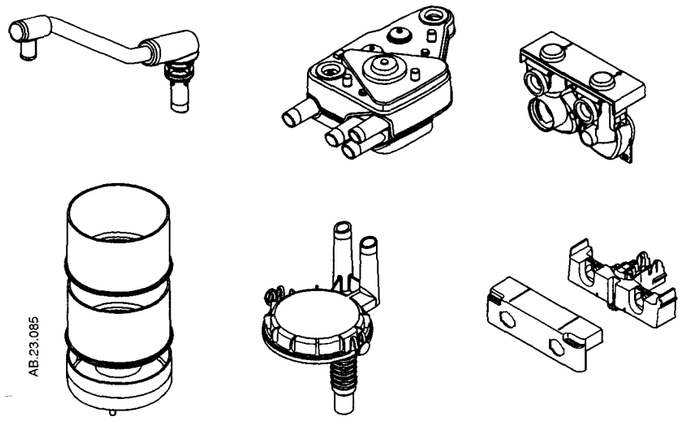
Figure 2-2 • These parts do not send gas back to the patient

Clean and sterilize

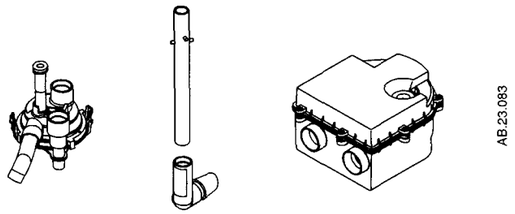
The Disassembly part of this section tells you how to remove parts for cleaning

To wash (by hand or machine)

Patient path



Scavenging path



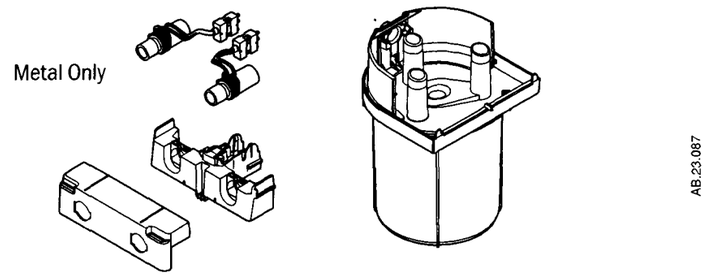
Use a mild detergent (pH <10.5). Then, rinse and dry completely. All parts except the O_2 sensor, and flow sensors can be washed.

User maintenance tells you how to disassemble parts and clean inside them if necessary.

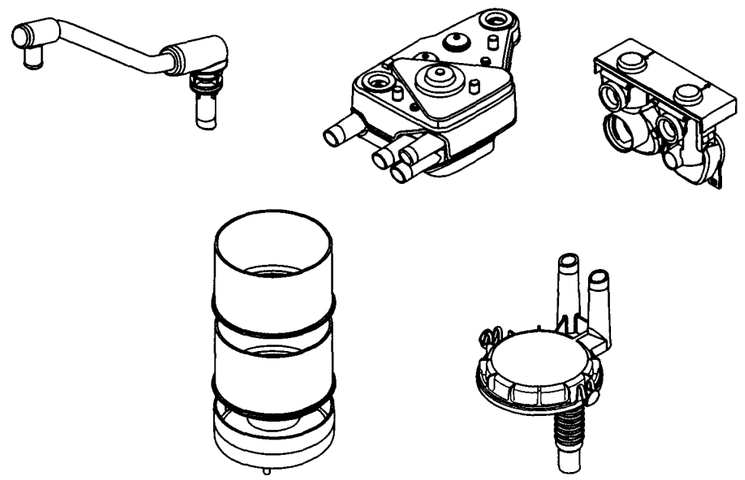
Autoclave

Patient path

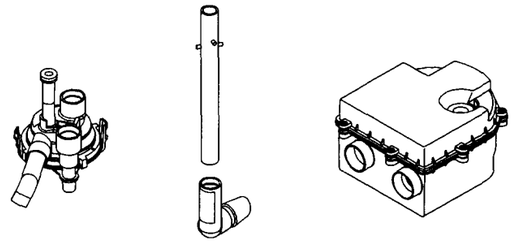
Metal Only



Upside down

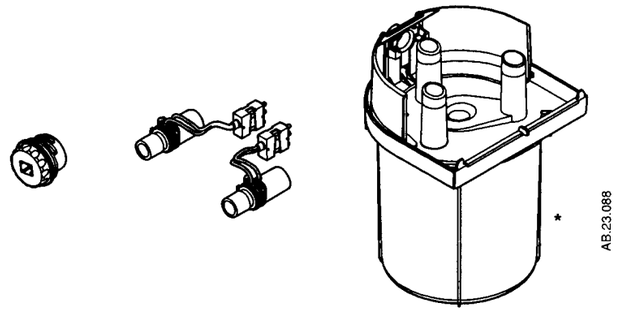


Scavenging path



Autoclave at 134°C. Inspect the parts for deterioration. The user maintenance section tells you how to do this.

Special requirements



* Hang the bellows upside down (extended) to dry. If not, the convolutions can stick together.

- To clean the circuit O_2 sensor, wipe it with a damp cloth. Do not put the sensor in liquid.
- To clean/disinfect metal/or plastic flow sensors, use the flow sensor cleaning procedure. Do not get the connectors wet
- Disassemble the bellows before you wash it. If not, it will take a very long time to dry. Hang the bellows upside down to dry.
- Assemble the bellows before you autoclave. Autoclave the bellows upside down.

⚠ **WARNING** Do not use talc, zinc stearate, calcium carbonate, corn starch or equivalent materials to prevent tackiness. These materials can go into the patient's lungs and airways and cause irritation or injury.

⚠ **CAUTION** Do not put the circuit O_2 sensor or flow sensor connector in liquid.

⚠ Do not autoclave the Circuit O_2 sensor or the plastic flow sensors.

⚠ Do not clean the interior surfaces of the flow sensors. Use a damp cloth on external surfaces only.

Assemble

The Set-up section tells you how to assemble the breathing system.

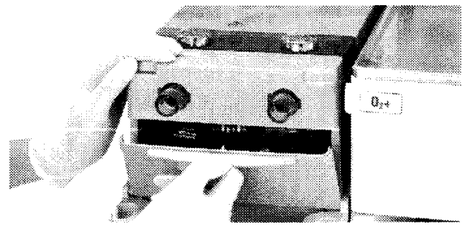
Inspect all parts for deterioration. Replace them if necessary.

The Preoperative tests in part 1 (the first half of this manual), tell you how to test the system for correct operation.

Disassemble the patient path

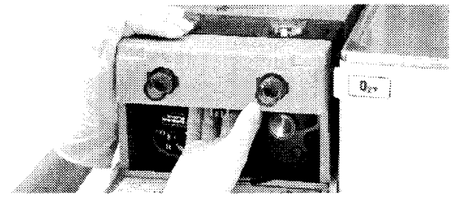
Step 1

Open the access panel.



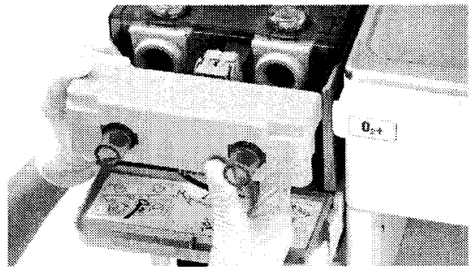
Step 2

Push up on the latch located under the flow sensor module.



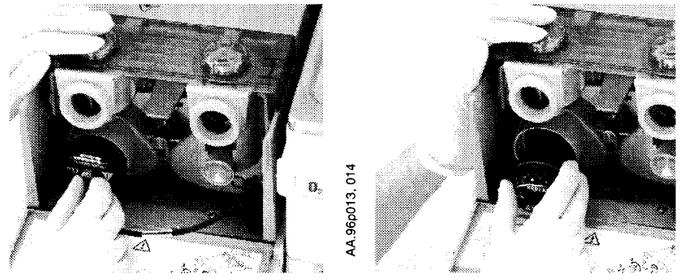
Step 3

Remove the flow sensor module. You will feel some resistance. Continue to pull.



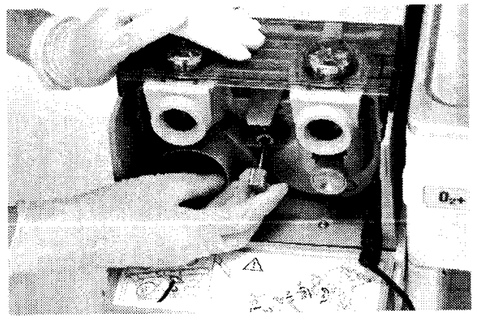
Step 4

Disconnect the cable and remove the O_2 sensor.



Step 5

Completely loosen the thumbscrew on the breathing circuit module.



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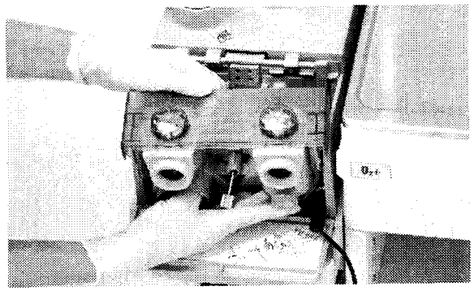
Step 6

Remove the module. You will feel some resistance. Continue to pull.



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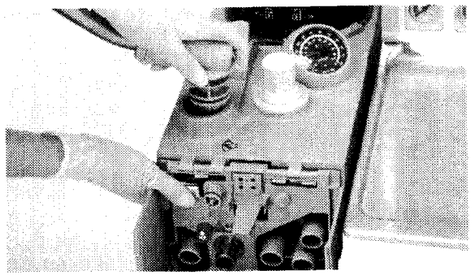
Step 7

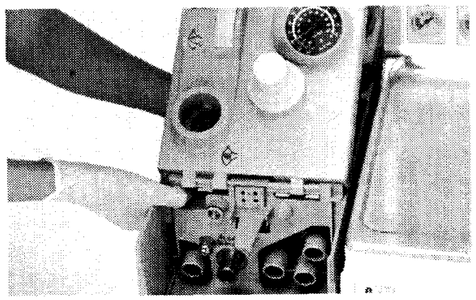
Push the metal button to the first stop. Pull out the bag arm.



AA.96p018

Step 8

Push the metal button to the second stop and open the top panel.



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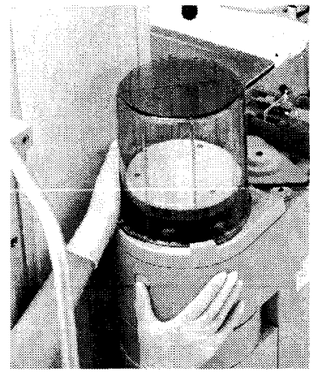
Step 9

Push the release button and remove the bellows assembly (pull up).



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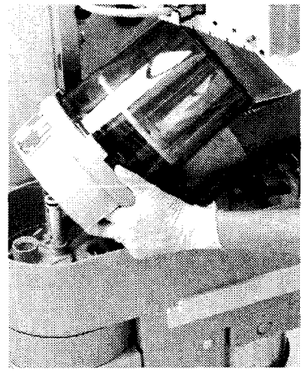
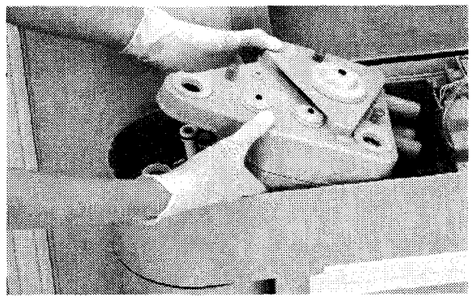


Step 10

Remove the main manifold.



AA.96p024

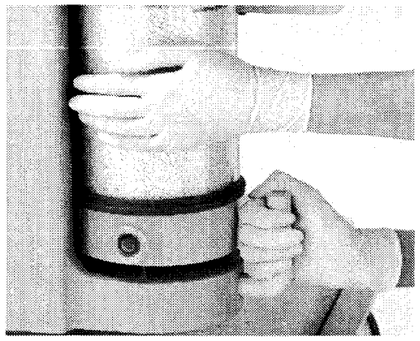
Autoclave assemblies marked 134°C. Refer to the Section "Clean and sterilize" for complete instructions. To assemble the circuit refer to the Setup Section.

Canister disassembly

⚠ **CAUTION** To prevent damage, pull the release handle forward. Then turn the handle

Step 1

Pull the release forward.



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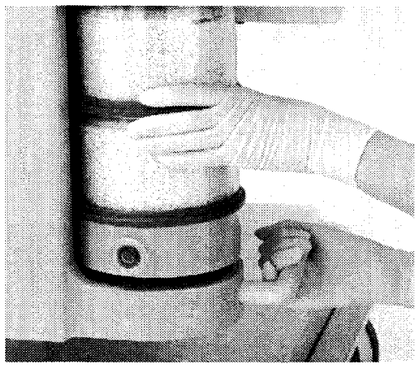
Step 2

Turn the release clockwise.



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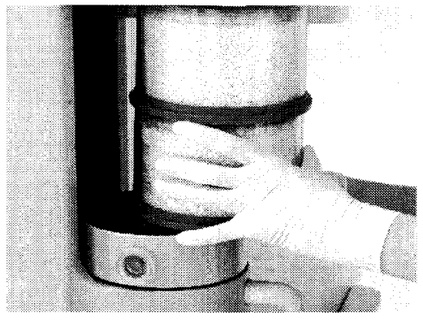
Step 3

Pull down and out on the canisters.



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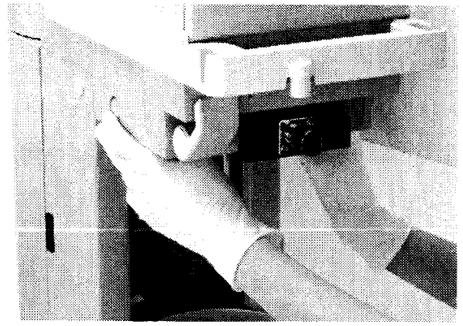
Step 4

Push in the buttons on each side of the top dish.



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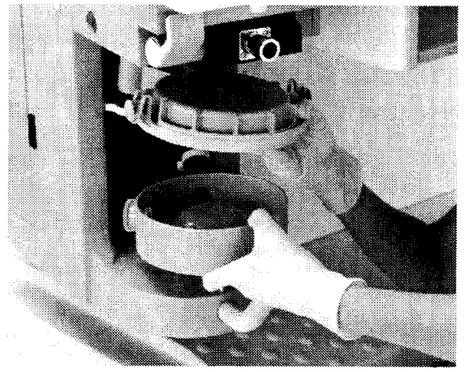
Step 5

Lift up the drain dish.

Remove the top dish and drain dish.



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Continue with the next section or go to Cleaning and sterilization. To assemble, refer to the Setup Section.

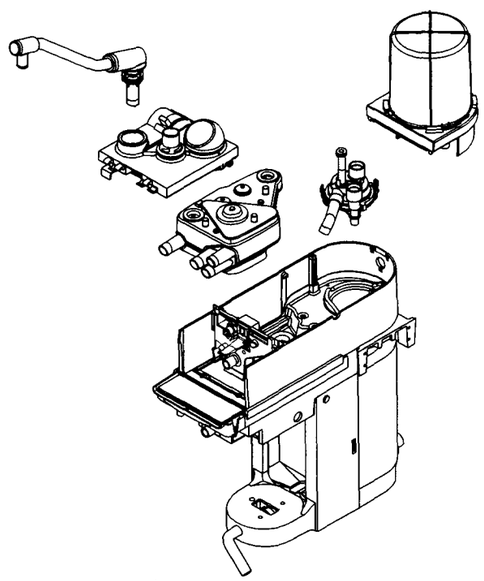
Disassemble the scavenging path

These parts send exhaled gas to the disposal system, not the patient.

Exhalation valve

Complete the basic disassembly procedure.

Push in the latches and pull out the exhalation valve.

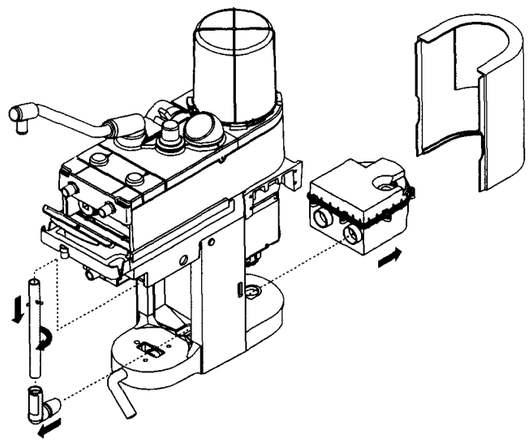


Scavenging reservoir

Loosen the knob and remove the rear cover.

Pull the reservoir up and to the rear.

Twist and pull down to remove the tube.



How to clean and disinfect the flow sensors

⚠CAUTION Do not autoclave plastic flow sensors.

⚠ Do not use high pressure gas, or brushes to clean the flow sensors.

⚠ Do not use cleaning solvents that are not approved for use with Polycarbonates (e.g. CIDEX Plus).

CIDEX sterilization

Both Datex-Ohmeda and the manufacturer of CIDEX (Johnson & Johnson) have tested this procedure.

- CIDEX must be 14 day mixture, with activator vial REF REORDER # 2245
- One liter of this solution cleans four (4) flow sensors

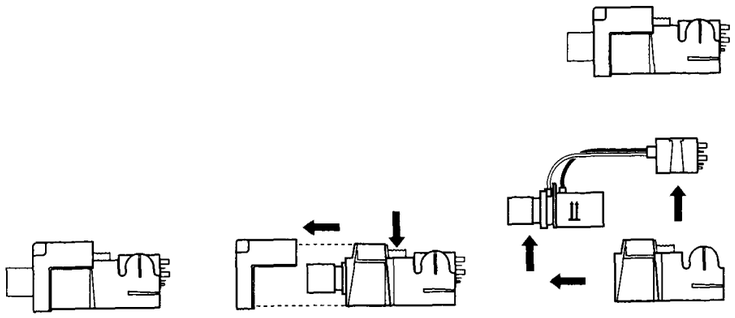
Procedure (Figure 2-3)

1. Remove the flow sensor module from the absorber. Refer to **"Disassemble the patient path"** in this chapter.
2. Remove the flow sensors from the module.
   - Push in the latch.
   - Pull off the cover.
   - Remove the flow sensors.
3. Submerge the flow sensor and tubes in activated CIDEX solution. Keep the connector dry.
4. Keep the solution in the tubes for the sterilization period.
5. Submerge the flow sensor and tubes in distilled water. Again, do not get the connector wet.
6. Rinse as indicated in CIDEX instructions.
7. Do steps 5 and 6 again to remove all CIDEX.
8. COMPLETLY dry the flow sensor and the tubes before you use the sensor.

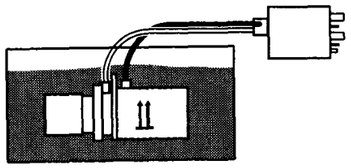
Use a dry syringe, or connect vacuum or pressure to remove all liquid from the sensor (sensor, tubes, and connector):

- Minimum time: 1 min
- Maximum vacuum: 30 in Hg
- Maximum flow: 10 l/min flow
- Maximum pressure: 345 kPa (50 psi).

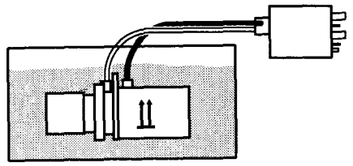
Step 2



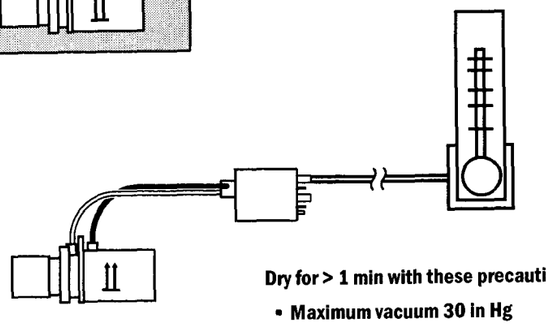
Steps 3 and 4



Steps 5, 6 and 7



Step 8



Dry for > 1 min with these precautions:

- **Maximum vacuum 30 in Hg**
- **Maximum flow 10 l/min**
- **Maximum pressure 345 kPa (50 psi)**

Figure 2-3 • Steps 2-8

Setup and Connections

Important Datex-Ohmeda strongly recommends that you use O_2 monitoring with this equipment. Refer to local standards for mandatory monitoring.

Important European Standard EN 740 requires anesthetic agent monitoring when anesthetic vaporizers are in use.

Important European Standard EN 740 requires CO_2 monitoring during ventilation.

⚠ **WARNINGS** Always make sure that the pipeline supply hoses and the breathing circuit components are not toxic and will not:

- Cause an allergic reaction in the patient.
- React with the anesthetic gases or agent to produce dangerous by-products.

⚠ To prevent incorrect values or equipment malfunction, use only Datex-Ohmeda cables, hoses and tubing.

⚠ This system operates correctly at the electrical interference levels of IEC 601-1-2. Higher levels can cause nuisance alarms that may stop mechanical ventilation.

⚠ To help prevent false alarms from devices with high-intensity electrical fields:

- Keep the electrosurgical leads away from the breathing system and the flow and oxygen sensors.
- Do not put the electrosurgical leads on any part of the anesthesia system.

⚠ To protect the patient when electrosurgical equipment is used:

- Monitor the correct operation of all life support and monitoring equipment.
- Keep backup manual ventilation available in case the electrosurgical equipment prevents safe use of the ventilator.
- Do not use conductive masks or hoses.

In this section

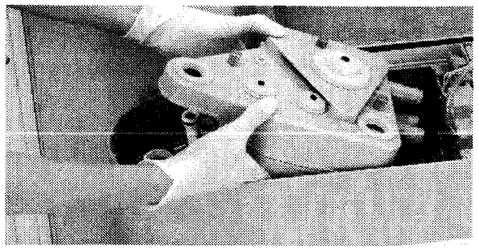
Breathing system setup 3-2
Canister Setup 3-6
Pneumatic and electrical connections 3-7
How to install gas cylinders (high pressure leak test) 3-11
How to attach equipment to the top shelves 3-14
How to install equipment on the foldout shelf 3-16
Installation notes 3-17

Breathing system setup

To assemble the patient circuit, start at step 5.

Step 1

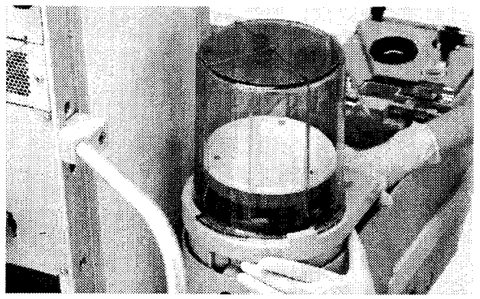
Install the main manifold.


AA.96p024

Step 2

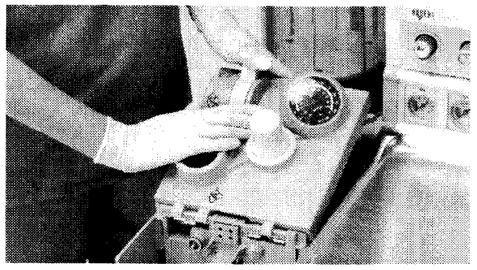
Install the Bellows.

- Make sure the release button aligns correctly.


AA.96p022

Step 3

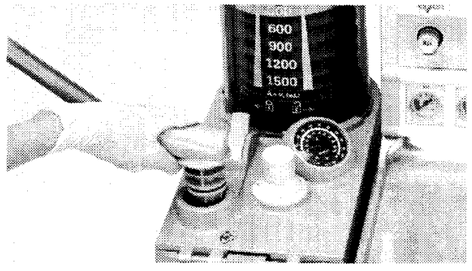
Gently close the control panel.


AA.96p012

Step 4

Install the bag arm.

- Install a rebreathing bag on the bag arm.

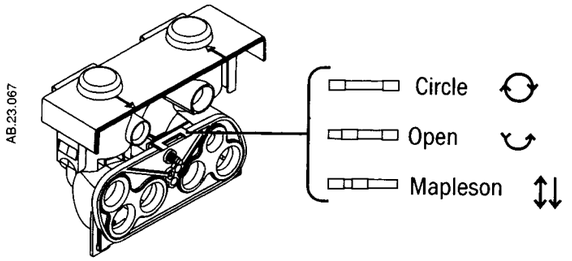


AA.96p019

Step 5

Identify the breathing circuit module (Circle, Mapleson, or Open).

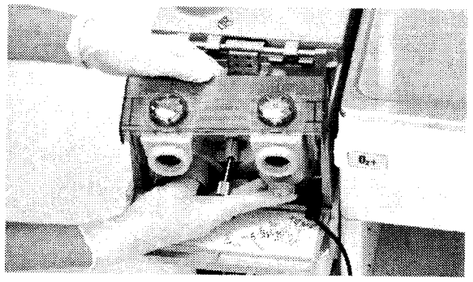
Look at the tabs on the rear or the label on the front.



AB.23.067

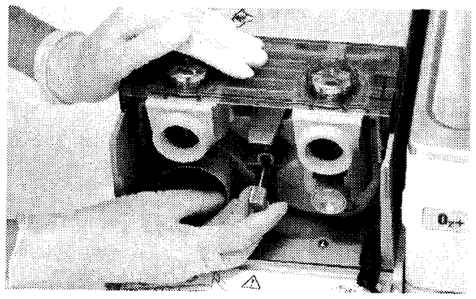
Step 6

Install the breathing circuit module. You will feel some resistance. Continue to push.


AA.96p017

Step 7

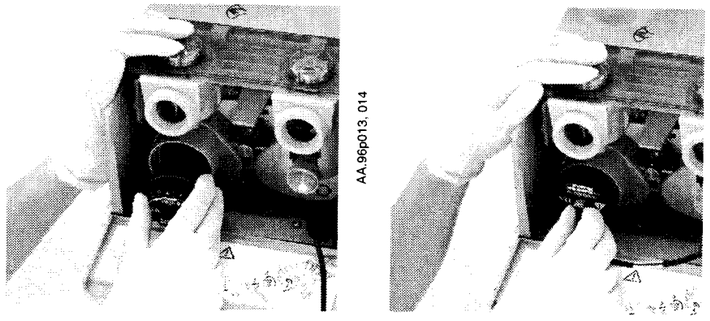
Completely tighten the thumbscrew


AA.96p016

Step 8

Install the O_2 sensor.

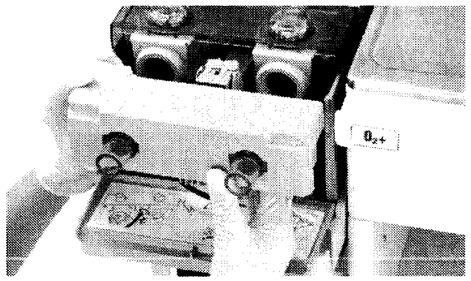
- Completely tighten the sensor.
- Connect the cable.


AA.96p013, 014

Step 9

Install the flow sensor module.

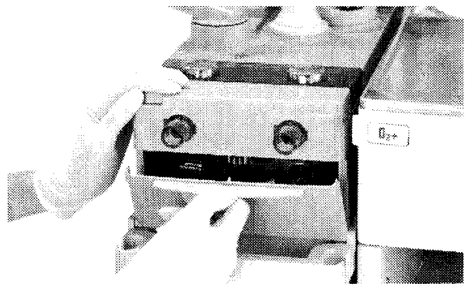
- You will hear a "click" when it locks into position.
- Refer to note 1 or the user maintenance section.



AA.96p011

Step 10

Close the front panel.



AA.96p009

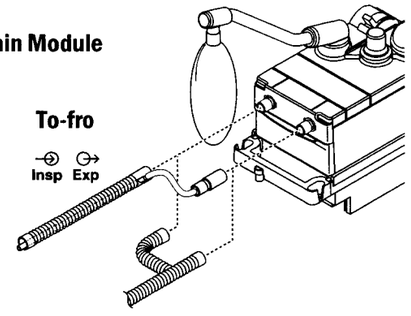
Step 11

Connect the patient circuit.

Circle or Open Module

AB.23.104

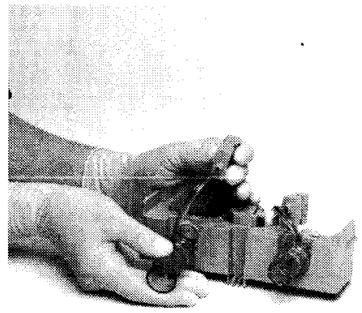
Mapleson D / Bain Module



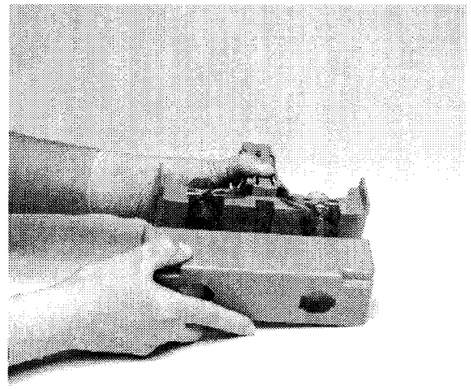
AB.23.152

Note 1

Flow sensor assembly



AA.96p039



AA.96p038

Canister Setup

Each canister holds 1.35 kg of loose absorbent or 1.13 kg of commercially packaged (pre-pack) absorbent. Datex-Ohmeda recommends Sodium or Barium hydroxide based absorbent.

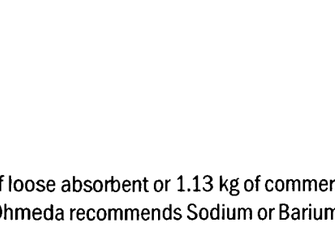
⚠ **WARNING** Change absorbent often to prevent the build up of non-metabolic gases when the system is not in use.

Inspect absorbent at the end of a case. During non-use, absorbent can go back to the original appearance. Refer to the absorbent labeling for more information about color changes.

If the absorbent completely drys out, it may give off CO (carbon monoxide) the next time you use it. For safety, replace the absorbent.

Step 1

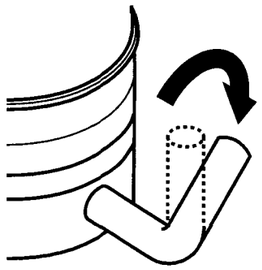
Pull the release forward.



AB.23.061

Step 2

Turn the release clockwise

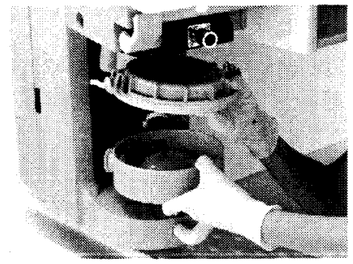


AB.23.061

Step 3

Push in the buttons and install the top dish and drain dish.

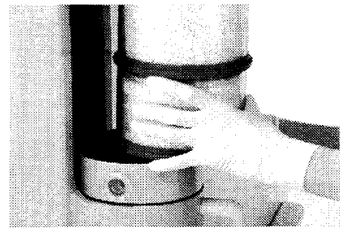
Pull down to make sure the top dish is locked in place.



AA.96p054

Step 4

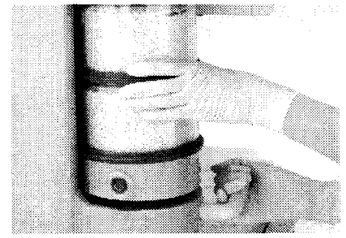
Fill the canisters with absorbent and install them. Push down on the drain dish if necessary.



AA.96p029

Step 5

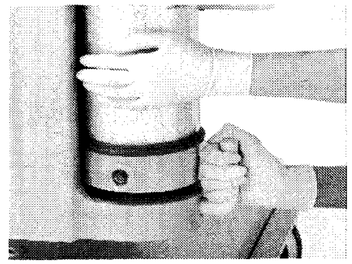
Turn the release counter-clockwise.



AA.96p028

Step 6

Push in the release.



AA.96p026

Pneumatic and electrical connections

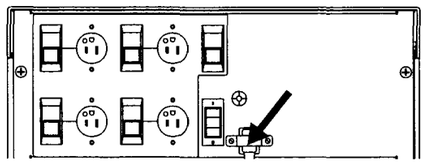
⚠WARNING Equipment connected to the electrical outlets can increase the leakage current. Regularly test the leakage current.

⚠CAUTION Use only medical grade gas supplies. Other types of gas supplies may contain water, oil, or other contaminants.

The Aestiva gas supplies also supply these devices through internal connections:

- The venturi suction regulator (optional)
- The external O_2 flowmeter (optional)
- Ventilator drive gas
- Pneumatic outlets

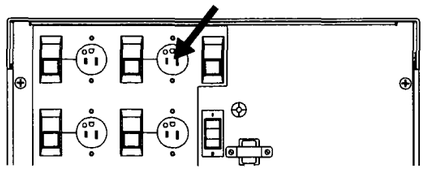
Mains inlet



AA.96.116

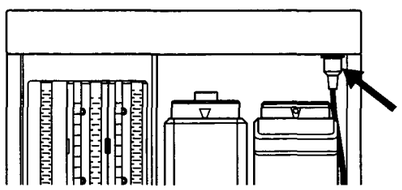
Outlets

Labels show **outlet voltage** ratings and circuit breaker amp ratings.



AA.96.116

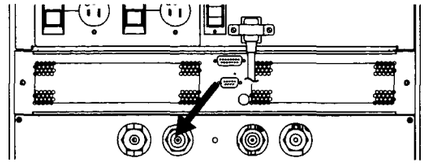
Tec 6 power



AA.96.095

Pipeline inlets

Label identifies the gas.

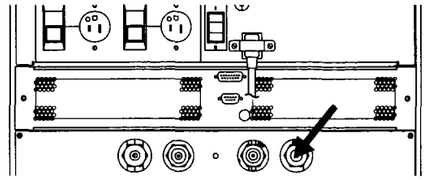


AA.96.116

Pneumatic outlet

Labels identify the gas.

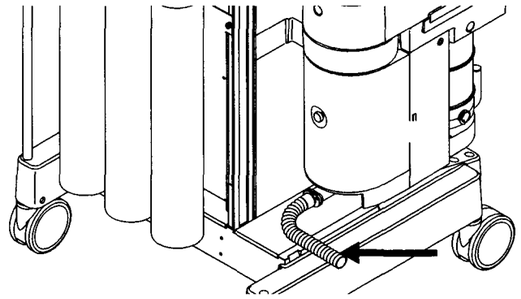
Note: The outlet pressures range from pipeline pressure to 550-690 kPa when cylinder supplies are used.



AA.96.116

Scavenging

Adapters may be necessary. Refer to the Illustrated parts section.

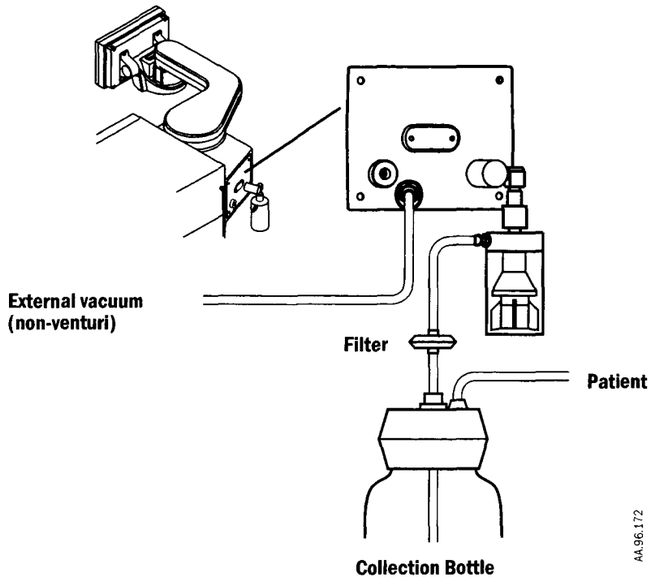


AA.96.137

Suction regulator

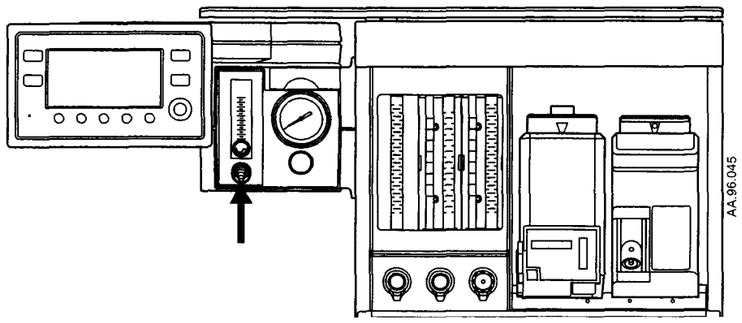
Optional item.

Note: Venturi regulators use the system air or O_2 supply. Standard regulators must be connected to an external vacuum supply.



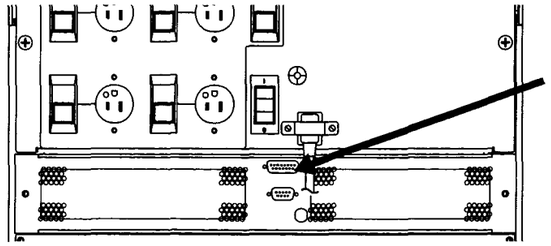
External O_2 flowmeter

Optional item.



Serial port

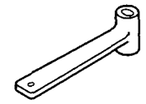
Refer to the communications appendix for command and data formats.



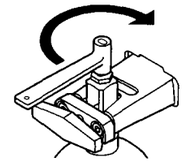
How to install gas cylinders (high pressure leak test)

Cylinder yokes

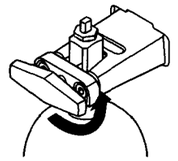
1. Find the cylinder wrench.



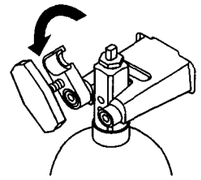
2. Close the cylinder valve on the cylinder to be replaced.



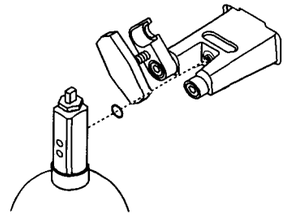
3. Fully loosen the tee handle.



4. Open the cylinder yoke.



5. Remove the used cylinder and the used gasket.



6. Remove the cap from the cylinder valve on the new cylinder.
7. Point the cylinder valve away from all flammable items and items that can be damaged by a release of pressure.
8. Quickly open and close the cylinder valve. This removes dirt from the cylinder outlet.

⚠ **CAUTION** No gasket or more than one gasket can cause a leak.

9. Install a new gasket.
10. Align the cylinder post with the index pins.
11. Close the yoke gate and tighten the tee handle.
12. Install a cylinder plug and gasket in all empty cylinder yokes.
13. Do a high pressure leak test:
    - Disconnect pipeline supplies.
    - Disconnect all equipment from the pneumatic outlet and turn OFF the auxiliary flowmeter.
    - Set the system switch to Standby.
    - Open the cylinder.
    - Record the cylinder pressure.
    - Close the cylinder.
    - If the cylinder pressure decreases more than 690 kPa in one minute, there is a leak.

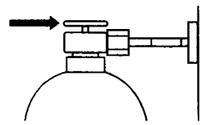
To repair a leak:

- Install a new cylinder gasket and tighten the tee handle.
- Do this step again. If the leak continues, do not use the system.

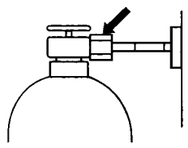
⚠ **WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

DIN connections

1. Close the cylinder valve on the cylinder to be replaced.



2. Loosen the adapter and remove the cylinder.



3. Remove the cap from the cylinder valve on the new cylinder.
4. Point the cylinder outlet away from all items that can be damaged by a release of high pressure gas.
5. Open and immediately close the cylinder valve to remove dirt or contaminants.
6. Do a high pressure leak test:
    - Disconnect pipeline supplies.
    - Disconnect all equipment from the pneumatic outlet and turn OFF the auxiliary flowmeter.
    - Set the system switch to Standby.
    - Open the cylinder.
    - Record the cylinder pressure.
    - Close the cylinder.
    - If the cylinder pressure decreases more than 690 kPa in one minute, there is a leak.

To repair a leak:

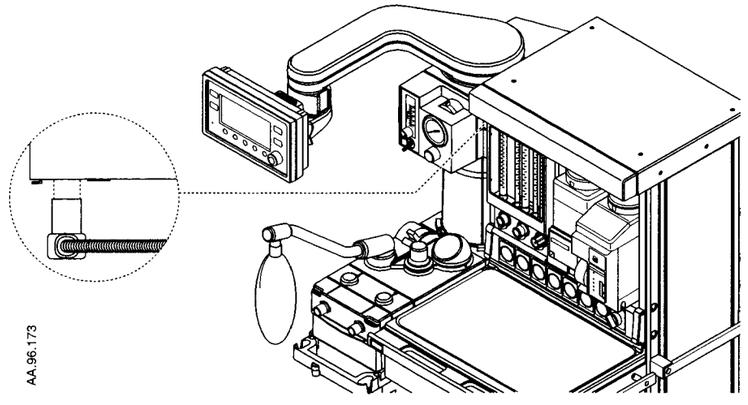
- Install a new cylinder gasket and tighten the tee handle.
- Do this step again. If the leak continues, do not use the system.

⚠ **WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

How to install the gooseneck lamp (12 V)

⚠**WARNING** Use ONLY 2.4 Watt bulbs. Higher wattage bulbs can get hot enough to burn you.

1. Align the connector with the cable towards you.



2. Push the connector firmly into the socket until you hear a click.
3. Move the light into position.

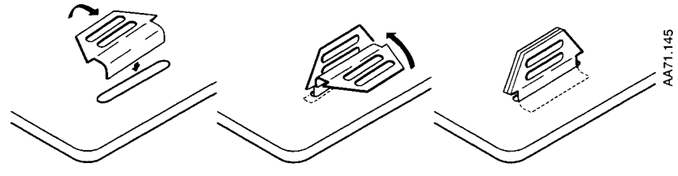
How to attach equipment to the top shelves

The basic system has two straps for equipment. Accessory shelves use clips and straps.

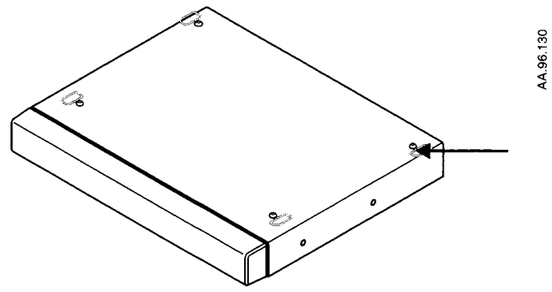
⚠ **CAUTION** Each accessory shelf has a weight limit of 23 kg (50 lbs).

⚠ Systems without accessory shelves have a weight limit of 23 kg (50 lbs).

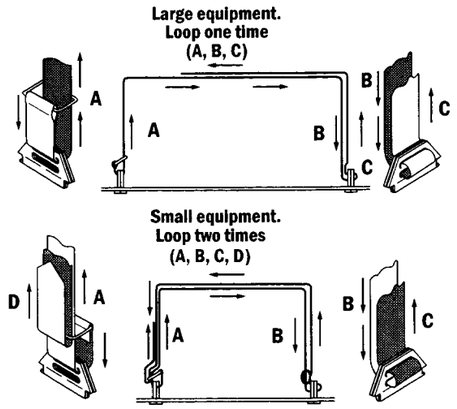
1. Install or find the clips:
   - With an accessory shelf, install the clips in the two slots nearest to the equipment.



   - Systems without accessory shelves have the clips attached.

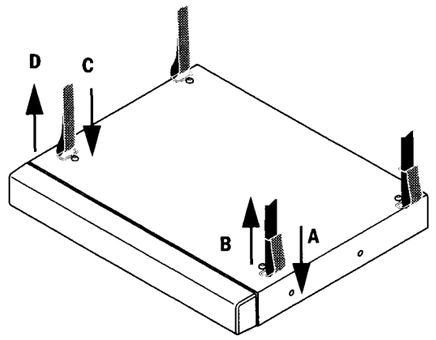


2. Install the straps:
   - With an accessory shelf:



AA.50.015

- Without an accessory shelf:



AA.96.135

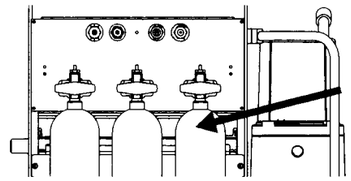
3. Fully tighten the straps.
4. Make sure that the straps hold the equipment in position.

⚠ **WARNING** If you do not fully tighten the strap, equipment can fall off the shelf.

How to install equipment on the foldout shelf

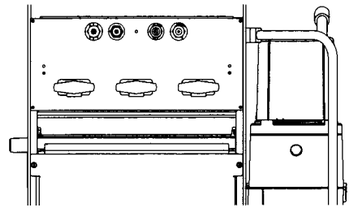
This is a hidden shelf for equipment that you do not need to look at, adjust, or touch. To access the shelf, you must remove the cylinders.

1. Make sure you have a cylinder wrench (if necessary).
2. Close the valves on all gas cylinders.
3. Remove all gas cylinders.

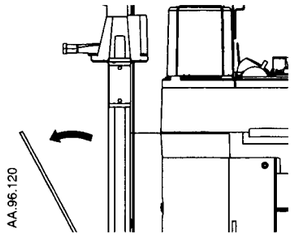


AA.96.118

4. Loosen the thumbscrews and open the rear door.

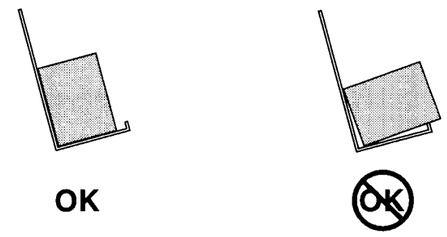


AA.96.119



AA.96.120

5. Put the equipment on the shelves.
6. Make sure the item does not hang over the raised edge.



AA.96.114

7. Connect all cables and route them through the cutouts in the door.
8. Close the door.
9. Test the equipment
10. Install the cylinders.

⚠ **WARNING** Items that hang over the raised edge can fall off.

Installation Notes

When the system is installed the service representative will check these settings and change them if necessary.

⚠**WARNING** These settings can only be changed by Qualified Service personnel.

- Language
- Power up defaults: When you turn the system off, should it save the current settings or go back to the facility defaults.
- Automatic calculation of V_E alarm limits during mechanical ventilation.
- Altitude
- Ventilator drive gas
- Heliox mode availability.

User Maintenance

⚠ **WARNING** TO PREVENT FIRES:

- Use lubricants approved for anesthesia or O_2 equipment, such as Krytox®[1].
- Do not use lubricants that contain oil or grease. They burn or explode in high O_2 concentrations.
- All covers used on the system must be made from antistatic (conductive) materials. Static electricity can cause fires.

⚠ **WARNING** Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

In this section

Repair policy 4-2
Manifold maintenance 4-3
Expiratory valve maintenance 4-6
Receiver maintenance (Filter) 4-8
Flow sensor maintenance 4-9
Breathing circuit maintenance 4-10
Bellows maintenance 4-12
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O_2 sensor calibration - 100% O_2 4-21
Flow sensor calibration 4-24
How to prevent water build-up 4-25

1. ® Krytox is a registered trademark of Dupont de Nemours E.I. & Company Inc

Repair policy

Do not use malfunctioning equipment. Make all necessary repairs or have the equipment serviced by an authorized Datex-Ohmeda service representative. After repair, test the equipment to ensure that it is functioning properly, in accordance with the manufacturer's published specifications.

To ensure full reliability, have all repairs and service done by an authorized Datex-Ohmeda service representative. If this cannot be done, replacement and maintenance of those parts listed in this manual may be undertaken by a competent, trained individual having experience in the repair of devices of this nature.

⚠ **CAUTION** No repair should ever be attempted by anyone not having experience in the repair of devices of this nature.

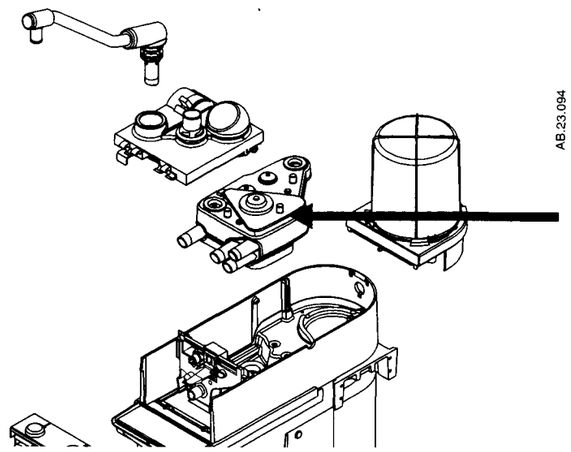
Replace damaged parts with components manufactured or sold by Datex-Ohmeda. Then test the unit to ascertain that it complies with the manufacturer's published specifications.

Contact the Datex-Ohmeda Field Service Support Center for service assistance. In all cases, other than where Datex-Ohmeda's warranty is applicable, repairs will be made at Datex-Ohmeda's current list price for the replacement part(s) plus a reasonable labor charge.

Manifold maintenance

Step 1

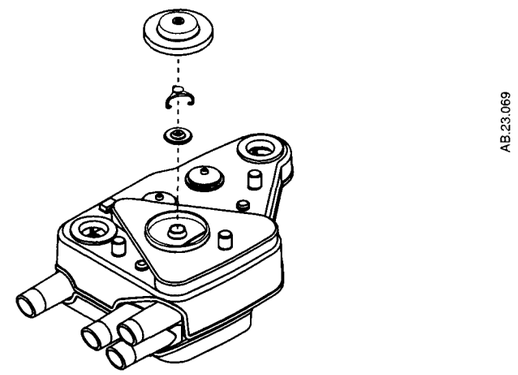
Complete the Basic disassembly (Refer to the Cleaning and sterilization section).



Step 2 (APL valve)[1]

Remove the diaphragm. Replace it if:

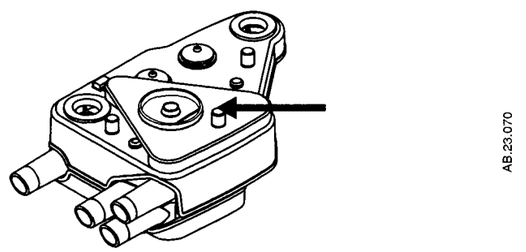
- The disk, cage, or diaphragm is damaged.
- The diaphragm looks worn.
- The diaphragm fits over the rim.



Step 3 (Seals)

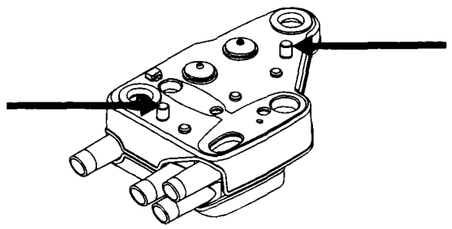
Loosen the thumbscrew and remove the plate.

- Replace the seal if damaged or worn.



Step 4 (Seals con.)

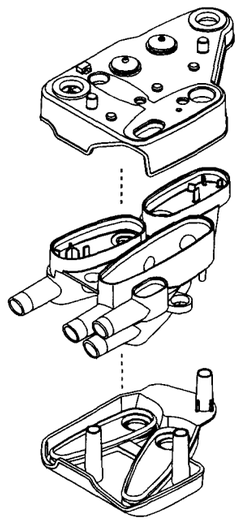
Loosen the thumbscrews.



AB.23.073

Step 5 (Seals con.)

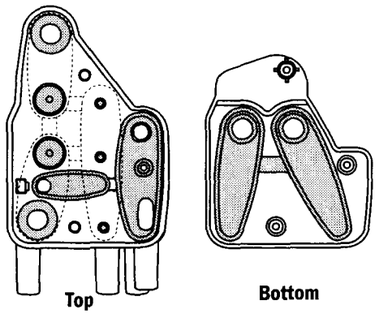
Open the manifold (top middle, and bottom parts).

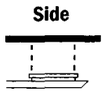


AB.23.074

Step 6 (Seals con.)

Replace the parts if they are damaged or worn.

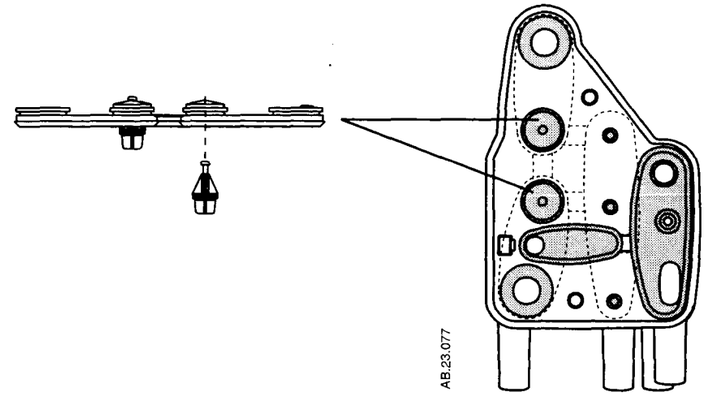




AB.23.071

Step 7 (Bag/Vent)[2]

Replace the parts if they are damaged or worn.

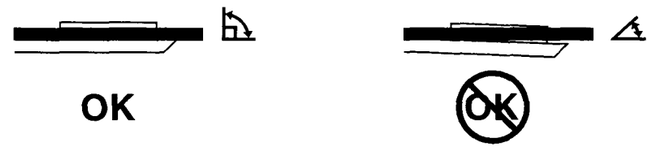


AB.23.077

Step 8

Put the parts together

- Make sure all gaskets are fully seated.
- Fully tighten the thumb-screws.



AB.23.075

1. When you turn the APL knob, you change the pressure that is necessary to push the disk up and permit gas to exit.
2. The Bag/Vent switch pushed down plungers to close the other path. In the Bag position, the vent path is closed, etc

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Expiratory valve maintenance

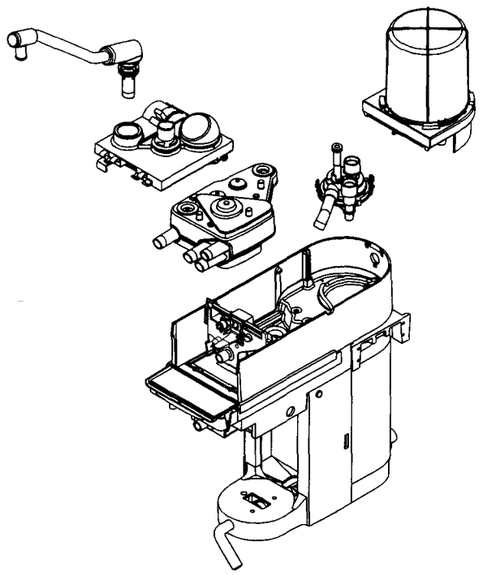
Disassemble the manifold and examine the seals at 12 autoclave cycles.

These conditions indicate a possible leak in the exhalation valve:

- A decrease in airway pressure during the inspiratory pause in the volume control mode of ventilation.
- Alarms for low tidal volume.
- The ventilator circuit has a leak, but the bellows pass the bellows tests in this section.

Step 1

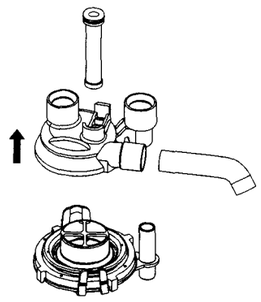
Remove the exhalation valve (Cleaning and sterilization section).



AB.23.089

Step 2

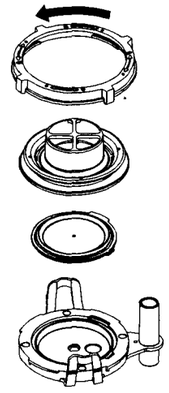
Remove the top cover.



AB.23.093

Step 3

Unscrew the lock ring (one quarter turn) and remove the cap.

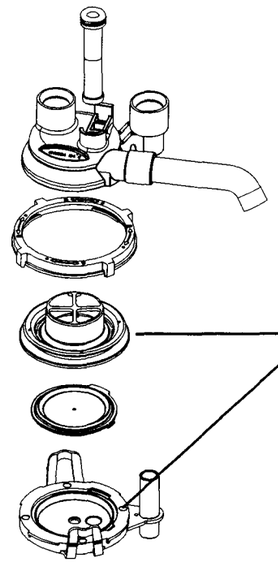


AB.23.072

Step 4

Put the parts together

- Align the dimples in the cap with the valve seat.
- To install the top, align it with the base and push down.



AB.23.021

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

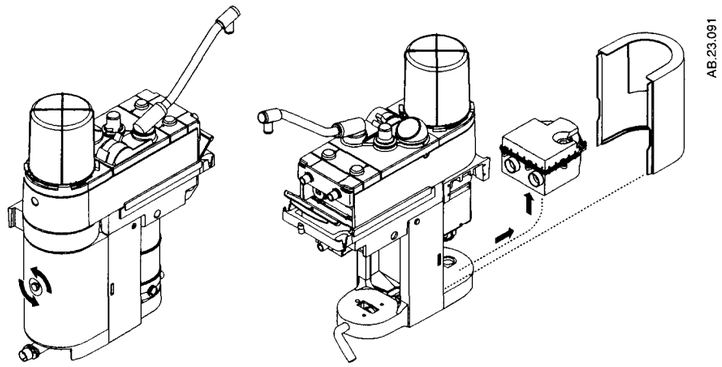
Receiver maintenance (active gas scavenging only)

A blocked filter decreases flow through the scavenging system. In extreem cases this can open the high pressure relief valve and vent to room air.

Note: Passive gas scavenging does not require maintenance.

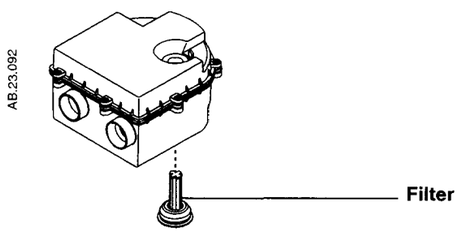
Step 1

Remove the receiver:
- Loosen the thumbscrew.
- Remove the rear cover
- Pull out and up on the receiver.



Step 2

Replace the filter (friction fit with gasket.)



⚠ **WARNING** This system operates correctly at the electrical interference levels of IEC 601-1-2. Higher levels can cause nuisance alarms that may stop mechanical ventilation.

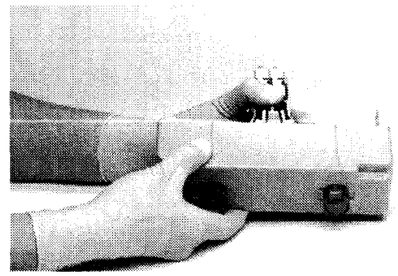
- Always make sure that the rear cover is installed.
- Completely tighten the thumb screw.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Flow sensor maintenance

Step 1

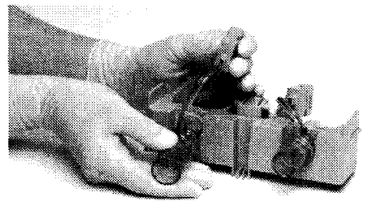
Remove the flow sensor module (Cleaning and sterilization section). Push in the tab and remove the cover.



Step 2

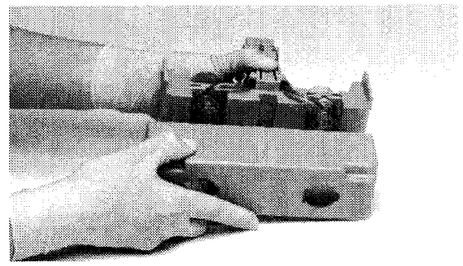
Install the new sensor with the arrows up.

Keep the tubes straight.



Step 3

Slide on the cover. Do not pinch the tubes.



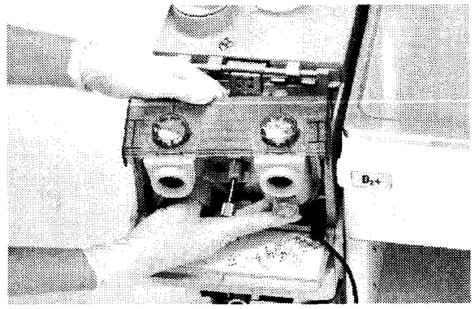
Before you use the system, complete the preoperative test procedure. Refer to th e Appendix of the System controls, operation, and checkout manual.

Breathing circuit maintenance

Disassemble the patient circuit module to replace check valves or seals.

Step 1

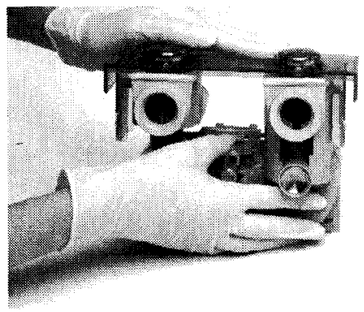
Remove the patient circuit module (Cleaning and sterilization section).



AA.96p.017

Step 2

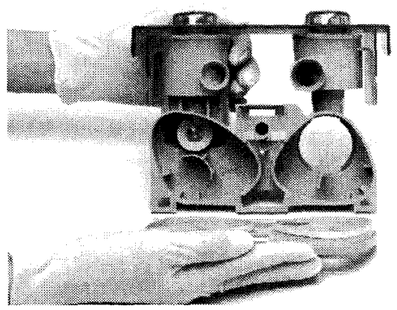
Hold in the tab.



AA.96p.041

Step 3

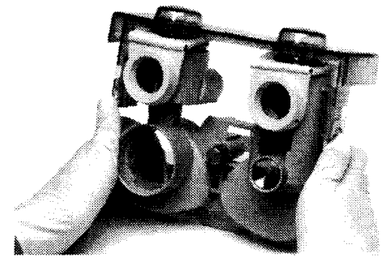
Remove the rear cover.
Note the rear seal is keyed to fit a specific module.



AA.96p.042

Step 4

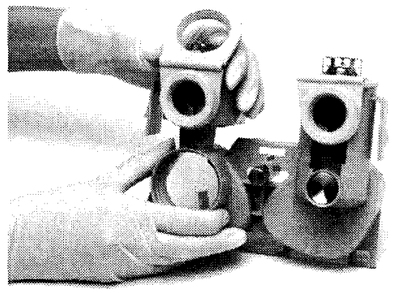
Push in the tabs and remove the top cover.



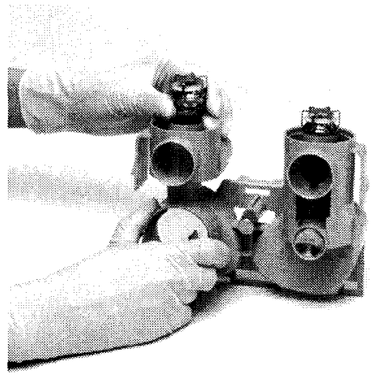
AA.96p.043

Step 5

Remove the seals.
Turn and pull to remove the check valves.



AA.96p.044



AA.96p.045

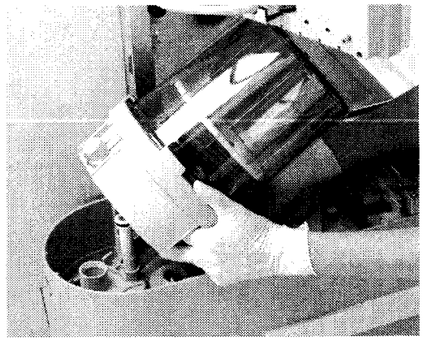
Do the steps in the opposite order to assemble the module.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Bellows maintenance

Step 1

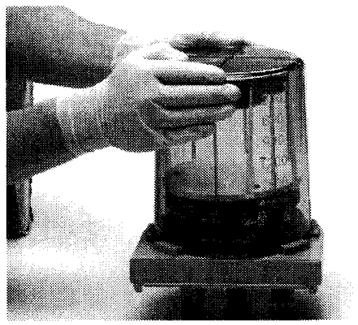
Remove the bellows from the breathing system.



AA.96p.023

Step 2

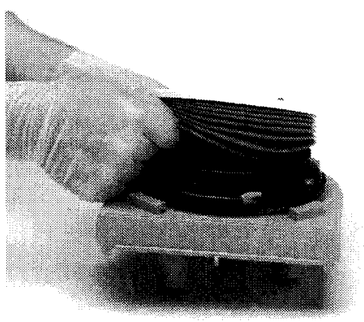
Turn the housing counter-clockwise and lift.



AA.96p.051

Step 3

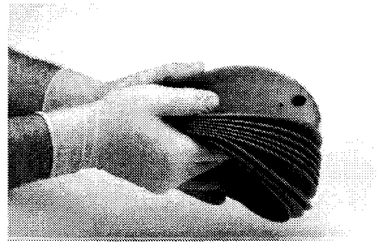
Remove the bottom edge of the bellows from the rim.



AA.96p.052

Step 4

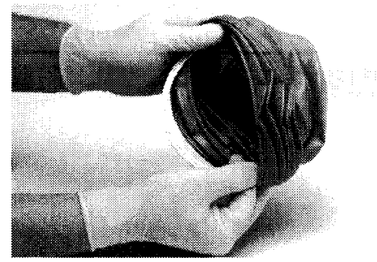
Remove the disk from the bellows.



AA.96p.031

Step 5

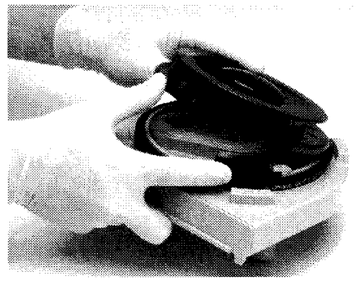
Remove the ring from inside the top of the bellows.



AA.96p.032

Step 6

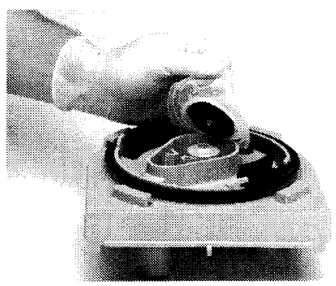
Push the latch toward the center and remove the rim.



AA.96p.033

Step 7

Remove the pressure-relief assembly.

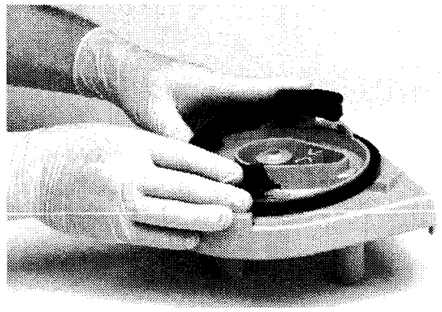


AA.96p.034

⚠ **WARNING** Do not disassemble the pressure relief valve. This can damage the seat or diaphragm and cause injury to the patient.

Step 8

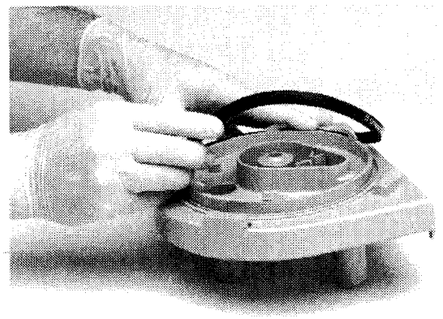
Push the latch towards the center and remove the locking tabs.



AA.96p.035

Step 9

Remove the seal.



AA.96p.036

Do these steps in the opposite order to assemble the bellows. If you see a dust like powder on the housing or the bellows, apply a thin layer of KRYTOX lubricant to the ribs of the bellows housing. Make sure the lubricant is applied smoothly and there are no lumps.

Make sure that:

- The arrow on the seal points up.
- You hear a double click when you install the rim.
- The rim is locked in position.
- The inner ring is correctly installed inside the top of the bellows.
- Only the bottom ring of the bellows fits over the rim.
- The housing is locked in position. You cannot lift it off.

Bellows tests

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

⚠ **WARNING** The bellows assembly test does not replace the preoperative tests. Always complete the tests in the section Preoperative tests before you use the system with a patient.

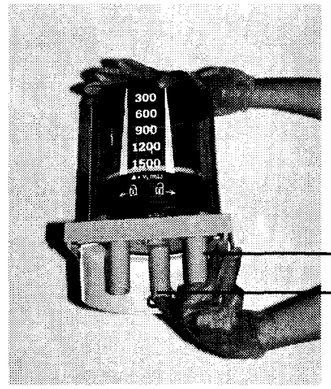
This test makes sure that all components are correctly assembled. It is not an alternative to a complete system checkout.

If the bellows operates correctly, install it in the system.

If there is a problem, disassemble the bellows. Look for and replace damaged parts.

Step 1

Hold the bellows assembly vertical and close the ports (A and B).



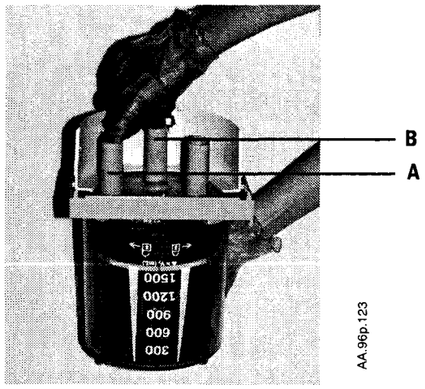
AA.96p.125

Step 2

Invert the bellows. They must not fall more than 100 ml/min.

If it does:

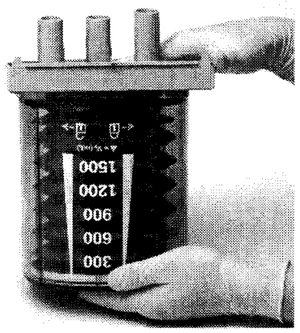
- The ports are not tightly sealed.
- The bellows is incorrectly installed.
- The seal inside the bellows is not correctly installed (with its groove pointed up).
- Parts are damaged.



AA.96p.123

Step 3

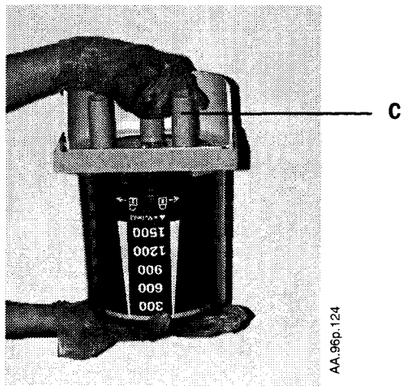
Remove the plugs from the ports. Permit the bellows to fully extend.



AA.96p.048

Step 4

Close port C.



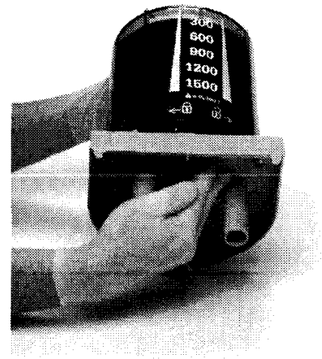
AA.96p.124

Step 5

The bellows must not fall more than 100 mL/min.

If it does:

- The port is not tightly sealed.
- The bellows or the pressure relief valve is not correctly installed.
- Parts are damaged.



AA.96p.050

If the result for all the bellows tests was "passed," install it in the system.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

O_2 sensor calibration - 21% O_2

This procedure takes three minutes or less.

You must do the 21% O_2 calibration before the 100% O_2 calibration. During O_2 calibration the screen replaces O_2 data with - -.

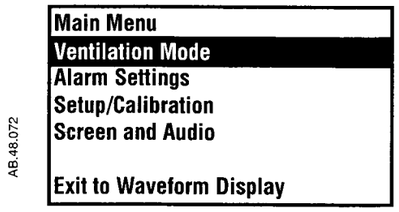
Step 1

Push the menu key.

AB.29.013

Step 2

Turn the knob to select **Setup/Calibration** (highlight).

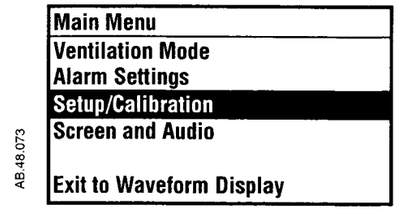

AB.48.072

Main Menu
Ventilation Mode
Alarm Settings
Setup/Calibration
Screen and Audio
Exit to Waveform Display

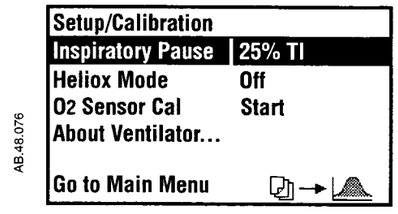
AB29.002

Step 3

Push the knob to show the next screen.


AB.48.073

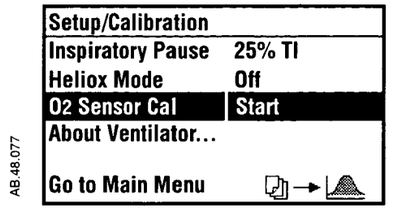
Main Menu
Ventilation Mode
Alarm Settings
Setup/Calibration
Screen and Audio
Exit to Waveform Display


AB.48.076

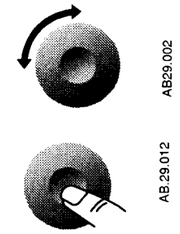
Setup/Calibration	
Inspiratory Pause	**25% TI**
Heliox Mode	Off
O2 Sensor Cal	Start
About Ventilator...	
Go to Main Menu	

Step 4

Turn then push the knob to select O_2 **Sensor Cal**.

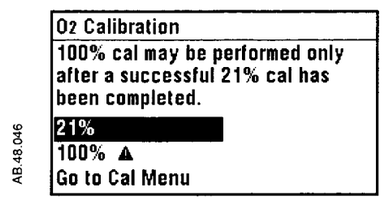

AB.48.077

Setup/Calibration	
Inspiratory Pause	25% TI
Heliox Mode	Off
O2 Sensor Cal	**Start**
About Ventilator...	
Go to Main Menu	

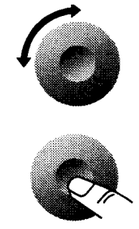

AB29.002
AB.29.012

Step 5

Select 21%. Then, push the knob.


AB.48.046

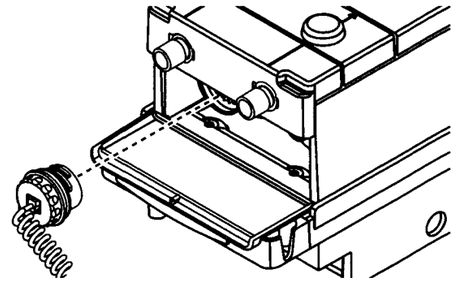
O2 Calibration
100% cal may be performed only after a successful 21% cal has been completed.
21%
100% ▲
Go to Cal Menu



Step 6

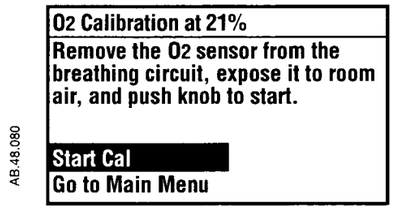
Complete the steps shown on the screen.

- Remove the O_2 senor from the circuit.
- Do not twist or stress the cable.
- Make sure the cable is connected.



Step 7

Select **Start Cal**.
Then, push the knob.


AB.48.080

O2 Calibration at 21%
Remove the O2 sensor from the breathing circuit, expose it to room air, and push knob to start.
Start Cal
Go to Main Menu

The screen shows "**Calibrating**", followed by the result (**"Complete"** or "**Failure"**).

After a sucessful calibration, the screen prompts you to put the O2 sensor back in the circuit.

If the calibration fails:

- Do the calibration again.
- If it still fails do a 100% O2 sensor calibration. If this passes, calibrate at 21% again.

After repeated failures, make sure that the altitude is correct (About Ventilator screen). Then, replace the O_2 sensor.

If the calibration passes, install the O_2 sensor. If necessary, do the 100% O_2 calibration.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

O_2 sensor calibration - 100% O_2

This procedure takes three minutes or less.

If ⚠ appears on the screen, you must complete the 21% calibration before you can select the 100% calibration.

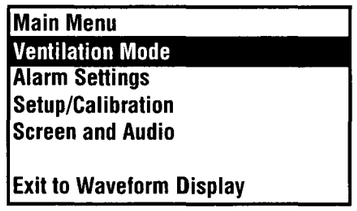
Step 1

Push the menu key.

AB.29.003

Step 2

Turn the knob to select **Setup/Calibration** (highlight).

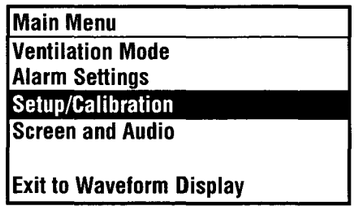


AB48.072

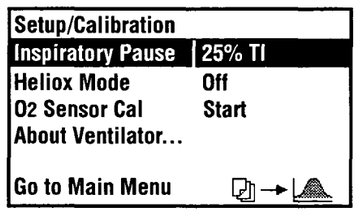
AB29.002

Step 3

Push the knob to show the next screen.



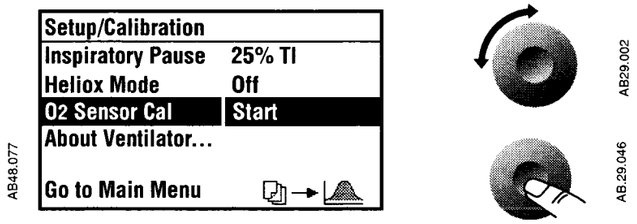
AB48.073



AB48.076

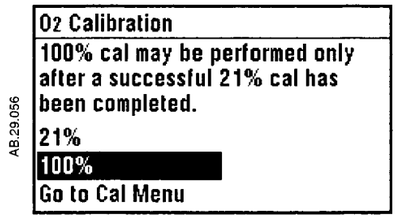
Step 4

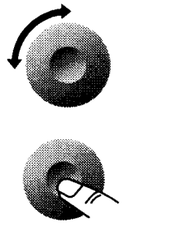
Turn then push the knob to select **O_2 Sensor Cal.**



Step 5

Select 100%. Then, push the knob.





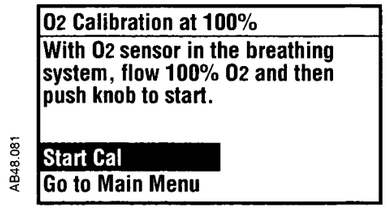
Step 6

With the O_2 sensor in the circuit, fill the circuit with 100% O_2:

- Push the flush button.
- Then flow 100% O_2 at 5 L/min.

Step 7

Select **Start Cal**.
Then, push the knob.


O2 Calibration at 100%
With O2 sensor in the breathing system, flow 100% O2 and then push knob to start.
Start Cal
Go to Main Menu
AB48.081

The screen shows "**Calibrating ...** ", followed by the result (**"Complete"** or "**Failure"**).

If the calibration fails,

- do it again. or,
- decrease the airway pressure. Then try again.

After repeated failures, make sure that the altitude setting is correct (About Ventilator screen). Then, replace the O_2 sensor.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Flow sensor calibration

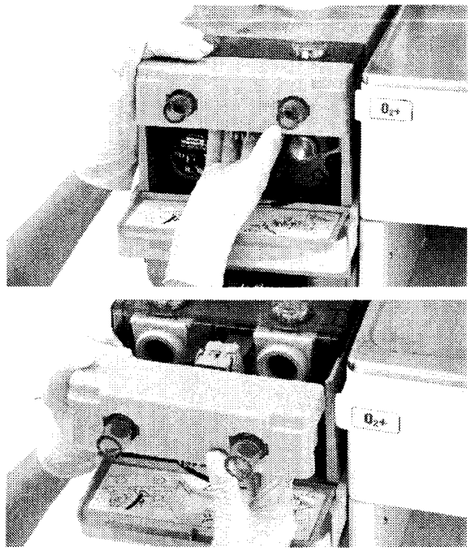
Minimum Frequency: Weekly

The system automatically corrects for zero offset when you unplug the flow sensor connectors with power on. You must stop mechanical ventilation before you calibrate the flow sensors.

Step 1

Push up on the latch under the flow sensor module.

Remove the flow sensor module. You will feel some resistance. Continue to pull.



AA.96p.010

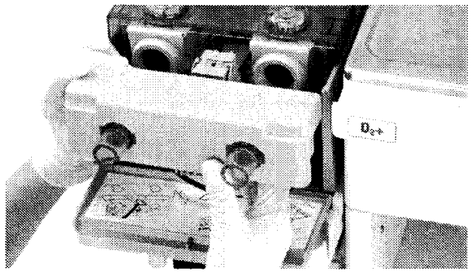
Step 2

When calibration is complete, the screen shows, "No Insp flow sensor" and "No Exp flow sensor"

No Insp Flow Sensor
No Exp Flow Sensor

Step 3

- Install the flow sensor module



How to prevent water build-up

Why is water buildup a problem?

Pooled water in the sensor or water in the sensing lines causes false alarms.

How much water is too much?

A thin layer of water or a foggy look in the flow sensors is OK. Drops of liquid water is too much.

Where does the water come from?

Water comes from exhaled gas and a chemical reaction between CO_2 and the soda lime in the absorber.

At lower fresh gas flows more water builds up because less gas is scavenged and:

- More CO_2 stays in the absorber to react and produce water.
- More moist, exhaled gas stays in the absorber

Solutions:

- Drain the absorber each morning.
- Drain all hoses as necessary.
- Flow sensor tubes must point up so that they do not collect water.
- With a circle breathing circuit, push the drain button before every case (listed in pre-operative procedures).
- If check flow sensor alarms ocurr during a VERY LONG case, replace the flow sensors Allow the original flow sensors to dry before you use them again.

Alarms and Troubleshooting

⚠**CAUTION** No repair should ever be attempted by anyone not having experience in the repair of devices of this nature.

In this section

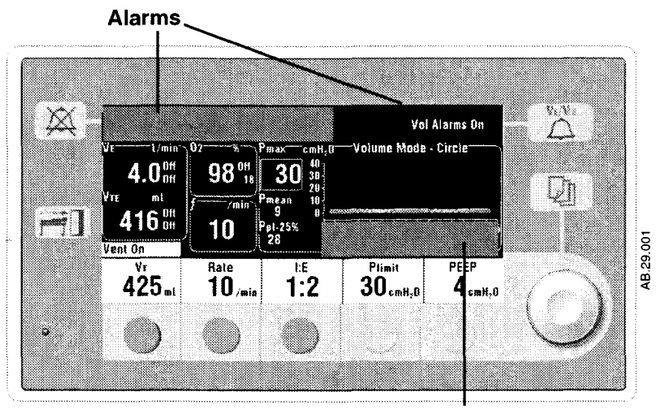
About alarms 5-2
Alphabetical list 5-4
Breathing system problems (no alarm) 5-16
Electrical problems (power failure, etc.) 5-17
Pneumatic problems 5-19

About alarms

⚠ **WARNING** If an alarm occurs, safeguard the patient first, before troubleshooting or repair procedures.

Two areas on the screen show alarms. The area at the top of the display shows most alarms. If there are more than 4 alarms at the same time, the lower priority alarms cycle every two seconds.

During severe malfunctions that prevent mechanical ventilation and/or monitoring, the area under the waveform shows minimum system messages. During normal operation, this area shows instructions (push the knob, etc.)



Alarm priority depends on the level of danger to the patient. High priority alarms require immediate attention. If an alarm is related to control settings, the limits flash and a box appears around the parameter.

Priority	Alarm tone	Alarm silence	Note
High	10 tones, 10 sec pause, repeat	120 Seconds or cannot be silenced	Reverse video. Screen shows elapsed time
Medium	3 tones, 25 sec pause, repeat	120 Seconds	----
Low	Single tone	Tone does not repeat	---

Alarm messages have three general causes:

- Malfunctions. Some malfunctions cause reduced function (for example no PEEP). Others prevent mechanical ventilation (Minimum shutdown).
- Patient monitoring. These are high and low limit settings that you adjust.
- Informational. Control settings or system conditions can change operation. For example, if the audible circuit leak alarm is Off, the screen shows "Circuit leak audio Off" as a low priority alarm.

Alphabetical list

The instructions in this section tell you what you can do:

- During a case to protect the patient
- After the case to repair a problem

This table does not include operator instructions.

There are two special types of alarms:

- Minimum monitoring alarms stop mechanical ventilation.
- Minimum shutdown alarms stop mechanical ventilation and monitoring.

Message	Priority	Cause	Action/Concerns	Repair
+15V Analog Out-of- Range	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
-15V Analog Out-of-Range	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
12 Hour Test	Low	System in use for more than 12 hours without a power-up self test.	To do the test, move the system switch from Standby to On.	Not necessary. Informational
Absorber canister open	Medium	The canister release is open (large leak) without a bypass mechanism.	Close the canister release.	A switch checks the release position
Absorber top panel open	Medium	The top panel is not completely closed	Close the panel.	- - -
A/D Converter Failure	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
All Vent modes Available	Low	A condition that prevented one of the ventilation modes has cleared.	None. Indicates a return to normal operation. Select pressure control of volume control ventilation.	- - -

Message	Priority	Cause	Action/Concerns	Repair
Apnea Alarm in Standby	Low	Normal condition after End Case, power-up, or ACGO change from On to Off	Monitoring resumes after first breath (mechanical) or 2 breaths within 30 sec (non-mechanical).	- - -
Apnea Alarm Off	Low	The cardiac bypass option is selected (alarm limit menu)	Apnea alarms are normally turned off when this option is selected	- - -
Aux Comm Gas Outlet On	Medium (low after acknowledged)	The outlet selection switch is set to the auxiliary common gas outlet.	Connect the patient circuit to the auxiliary outlet. For mechanical ventilation or manual ventilation with monitoring, select the common gas outlet.	- - -
Battery Charger Fail	Low	The current in the battery charging circuit is too high.	The system is operational, but may fail later depending on what caused this alarm.	Contact a qualified service representative
Battery Charging	Low	The battery is not fully charged. If power fails, the total backup time will be less than 30 minutes.	Leave the system plugged in to charge the battery.	- - -
Battery Current High	Low	Battery current > 6 amps for 10 seconds	The system continues to operate but may fail	Contact a qualified service representative
Battery Failure High	Low	Battery voltage > 16 V for 10 seconds	The system continues to operate but may fail	Contact a qualified service representative
Battery Failure Low	Low	The battery voltage is too low (<7 V) to supply the system if power fails.	The battery does not have enough charge to power the equipment if power fails. Leave the system plugged in to charge the battery.	If the battery does not charge in 24 hours, contact a service representative.

Message	Priority	Cause	Action/Concerns	Repair
Calibrate Flow Sensors	Low	The last flow sensor calibration failed.	Calibrate the flow sensors. Look for water in the flow sensor tubes. Dry if necessary.	Contact a qualified service representative.
Calibrate O_2 Sensor	Low	O_2%>110%	Does the sensor measure 21% O_2 in room air?	Calibrate O_2 sensor.
Cardiac Bypass	Low	The alarm limit settings are set for a patient on cardiac bypass. Apnea alarms are off.	Use the alarm limits menu to change this setting.	- - -
Check Flow Sensors	Medium (low after acknow-ledged)	No flow or negative flow on inspiratory sensor during inspiration in a circle system or negative flow on expiratory sensor in expiration (for 6 breaths in a row).	Are the flow sensors correctly installed? Water build up in the flow sensor tubes? Is a flow sensor tube cracked or broken?	Inspect one way valves (breathing circuit module.) Replace flow sensor module with the spare. Check the condition of the flow sensor and its tubing.
Circuit Leak Audio Off	Low	Control setting on the Alarm limit menu.	This message tells you that the audio alarm for circuit leaks was turned off.	- - -
Connect O_2 Sensor	Low	The O_2 sensor is not connected to the cable.	Connect the sensor.	Contact a qualified service representative to replace the cable.
Control Settings Input has Failed	Min. monitoring (Medium)	Ventilator malfunction	Ventilate manually. Monitoring is still available.	Contact a qualified service representative.
CPU Failure	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.

Message	Priority	Cause	Action/Concerns	Repair
CPU Internal Error	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Display Voltage Out Of Range	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Exp Flow Sensor Fail	Low	The system cannot read the calibration data stored in the sensor.	Operation continues with default values. Replace the flow sensor.	- - -
Exp reverse flow	Medium (low after acknow-ledged)	Flow through the expiratory sensor during inspiration (for 6 breaths in a row).	Look at the check valves Water build up in the flow sensor tubes? Is a flow sensor tube cracked or broken?	Replace the expiratory check valve. Check the condition of the flow sensor.
Flow Valve Failure (DAC) Flow Valve Failure (current)	Min. monitoring (Medium)	Ventilator malfunction	Ventilate manually. Monitoring is still available.	Contact a qualified service representative.
Gas Inlet Valve Failure	Min. monitoring (Medium) or Min. shutdown (High)[1]	Ventilator malfunction	Ventilate manually. Monitoring is still available.	Contact a qualified service representative.
Hardware Watchdog Failure	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Heliox Mode is On	Low	Control setting on ventilation setup menu.	When heliox is used, the ventilator must adjust volume calculations.	- - -

Message	Priority	Cause	Action/Concerns	Repair
High O_2	Medium	O_2% > alarm high limit setting	Is the limit set correctly? What is the O_2 flow? Did you just push Flush? Does the sensor see 21% O_2 in room air?	Calibrate O_2 sensor. Replace O_2 sensor.
High Paw	High	Paw is greater than Plimit. The ventilator cycles to expiration.	Are Plimit and other controls set correctly? Look for blockages. Check the patient connection.	Calibrate the flow sensors. Replace the receiver filter.
High Pressure Limit Reached	Min. monitoring (Medium)	A pressure safety switch activated at a Paw <90 cm H_2O	Ventilate manually. Monitoring is still available. Extreme control combinations may cause this alarm. Check control settings.	Contact a qualified service representative.
High Ve	Medium	The minute volume is greater than the set high limit. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient for spontaneous breathing. Adjust control settings	---
High Vte	Medium	VTE is greater than high alarm limit. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient for spontaneous breathing. Check ventilator and alarm settings.	---
Insp Flow Sensor Fail	Low	The system cannot read the calibration data stored in the sensor.	Operation continues with default values. Replace the flow sensor.	---
Insp Reverse Flow	Medium (low after acknow-ledged)	Flow through the inspiratory sensor during expiration (for 6 breaths in a row).	Look at the check valves Water build up in the flow sensor tubes? Is a flow sensor tube cracked or broken?	Replace the inspiratory check valve. Check the condition of the flow sensor.

Message	Priority	Cause	Action/Concerns	Repair
Inspiration Stopped	High	Drive gas safety switch activated (high pressure)	Adjust controls. Check systems for blockages.	---
Internal Ventilator Clock Too Fast	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Internal Ventilator Clock Too Slow	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Invalid Circuit Module	Low	The system does not recognize the type of circuit module installed. Normally the system used the ID tabs to Identify circuits.	Make sure the module is correctly installed. Look for broken ID tabs or tape on the tabs	Contact a qualified service representative
Limit Task Light Use	Low	The system is running on battery power. Turn off the light to save power.	Turn off the light to extend battery backup.	---
Loss of Backup Audio	Medium (low after acknow-ledged)	The audio alarm will not sound for a CPU failure	Monitor system operation	Contact a qualified service representative
Low Battery Voltage	Medium	Voltage is <11.65V while using battery power	Manually ventilate the patient to save power.	Make sure power is connected and circuit breakers are close. Check ventilator fuse.
Low Drive Gas Pressure	Medium	The ventilator did not detect a rise in internal pressure when the flow valve opened.	Manually ventilate the patient.	Make sure that the appropriate gas supplies (O_2 or air) are connected and pressurized.

Message	Priority	Cause	Action/Concerns	Repair
Low O_2	High	O_2% < alarm low limit setting	Is the limit set correctly? Is the O_2 flow sufficient? Does the sensor see 21% O_2 in room air?	Calibrate O_2 sensor. Replace O_2 sensor. As sensors wear out, the measured % O_2 decreases.
Low Paw	Medium	Paw does not rise at least 4 cm from the lowest pressure measured during the last20 sec	Are circuit connections Ok? Look at the Paw gauge on the absorber.	Look for circuit disconnection.
Low Ve	Medium	Exhaled minute volume <low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient condition. Check tubing connec-tions. Check alarm settings.	---
Low Vte	Medium	Exhaled tidal volume <low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient condition. Check tubing connections. Check alarm settings.	---
Manifold Pressure Sensor Failure	Min. monitoring (Medium)	Ventilator malfunction	Ventilate manually	Contact a qualified service representative
Memory (EEPROM) Fail	Low	The system cannot access some stored values.	Default settings are used. Ventilation is still possible but service is necessary.	Contact a qualified service representative.
Memory (flash) Failure	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Memory (RAM) Failure	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Memory (Redundant Storage) Fail	Min. monitoring (Medium)	Ventilator malfunction	Ventilate manually. Monitoring is still available.	Contact a qualified service representative.
Memory (video) Failure	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Minimum Monitoring	Medium	A severe malfunction prevents mechanical ventilation.Other alarms may also occur.	Ventilate manually. Cycle system power (On- Standby-On). If the alarm clears, restart mechanical ventilation	Contact a qualified service representative.
Minimum system shutdown	High	A severe malfunction prevents mechanical ventilation and monitoring. Other alarms may also occur.	Ventilate manually. Use a stand-alone monitor. Cycle system power (On- Standby-On). If the alarm clears, restart mechanical ventilation	Contact a qualified service representative
No Circuit Module	Low	The patient circuit module is not installed.	Install a module. Refer to the setup section.	Optical sensors look for tabs on the back of the module. Is the module assembled? are the sensors dirty?
No CO_2 absorption	Medium (low after acknow-ledged)	The canisters are open (out of the circuit) but the bypass mechanism prevents a leak (optional feature)	User setting. Close the canister release to remove CO_2 from exhaled gas	---
No Exp Flow Sensor; No Insp Flow Sensor	Medium (low after acknow-ledged)	Electrical signals show the flow sensor is not connected	Connect the flow sensors. Make sure the flow sensor module is on all the way.	---

Message	Priority	Cause	Action/Concerns	Repair
No O_2 pressure	High (cannot be silenced)	The O_2 supply has failed.	Air flow will continue. Ventilate manually if necessary. Connect a pipeline supply or install an O_2 cylinder	---
O2 Flush Failure	Low	The pressure switch that detects flush flow has seen a very long flush (≥30 sec).	This alarm occurs if you hold down the Flush button for more than 30 seconds.	If the alarm occurs when flush is not in use, contact a qualified service representative.
O_2 sensor out of circuit	Low	O_2 sensor not installed in breathing circuit module; sensor not measuring gas in breathing circuit.	Install a breathing circuit module and an O_2 sensor.	---
On Battery-Check Power	Medium (low after acknowledge)	The mains supply is not connected or has failed and the system is using battery power	Ventilate manually to save power. At full charge, the battery permits approx. 30 min of mechanical ventilation.	Make sure power is connected and circuit breakers are closed. Check ventilator fuse.
Patient Circuit Leak	Medium	Exhaled volume <50% of inspired volume for at least 30 seconds (mechanical ventilation).	Check breathing circuit and flow sensor connections.	---
Paw < -10 cmH_2O	High	Subatmospheric pressure (<-10 cm H_2O)	Check patient condition, spontaneous activity? Increase fresh gas flow. Look for high flow through gas scavenging.	Calibrate the flow sensors.[2] With active scavenging, check the negative relief valve on the receiver.
Paw/manifold mismatch	Medium	The ariway pressure and an internal ventilator pressure do not track.	Ventilate manually.	Contact a qualified service representative.

Message	Priority	Cause	Action/Concerns	Repair
PEEP Not Achieved	Low	Pmin does not reach within 2 cm H_2O of PEEP by the end of mechanical expiration for 6 consecutive breaths.	Check tubing connections. Rate and/or I:E ratio may prevent ventilator from reaching desired PEEP level	---
Positive SIB Vref Out-of- Range	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Pres Control Available	Low	The ventilator is not fully functional but pressure control mode is available.	VT Compensation is Off. Ventilate manually or in the pressure control mode	---
Pres Control Not Avail.	Medium (pressure control); else low	Ventilator not fully functional and pressure control mode not available.	Ventilate manually or in the volume control mode	Contact a qualified service representative.
Pres/Vol Mon Inactive	Medium	Outlet selection switch is set to aux. gas outlet	Connect the patient circuit to the aux. gas outlet or set the switch to the common gas outlet for normal operation.	---
Replace O_2 Sensor	Low	O_2% < 5%	Makes sure patient receives O_2. Does the sensor see 21% O_2 in room air? Use different monitor.	Calibrate O_2 sensor. Replace O_2 sensor.
Schedule Cal Due	Low	Internal calibrations are necessary for maximum accuracy.	The system is operational	Contact a qualified service representative.
Select Gas Outlet	Medium	Fresh gas may not flow to the patient Aux. gas outlet is On, but flow sensors have seen 3 breaths in patient circuit during the last 30 seconds.	Select the common gas outlet or connect the patient circuit to the aux. outlet.	Note: the bag arm will not ventilate a patient at the aux. outlet.

Message	Priority	Cause	Action/Concerns	Repair
Software Watchdog Failure	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Sustained airway pressure	Min. shutdown (High)	Paw > 100 cm H_2O for 10 sec.	Check tubing for kinks, blockages, disconnects.	Calibrate the flow sensors.
Sustained Paw	High	Paw > sustained pressure limit for 15 seconds[3]	Check tubing for kinks, blockages, disconnects.	Calibrate the flow sensors.
System Leak?	Low	Delivered volumes do not match set volumes	If you are using Heliox, select Heliox on the ventilator setup menu. Look for leaks in the manifold. Compare set to delivered volumes	Calibrate the flow sensors. Drain water buildup from the breathing system.
Unable to Drive Bellows	Low	The internal manifold pressure is higher than Paw + tolerance.	Fill the bellows if empty.	- - -
Vaux_ref Out-of-Range	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Vext_ref Out-of-Range	Min. shutdown (High)	Ventilator malfunction	Ventilate manually. Monitoring is not reliable.	Contact a qualified service representative.
Verify Low VE Limit	Low	The audible circuit leak alarm is Off (Alarm menu) but the low VE alarm is not set.	Set the low VE alarm.	- - -
Volume Apnea	Medium	No mechanical breaths or spontaneous breaths >20 mL in last 30 seconds.	Check patient. Bag as needed. Check for disconnects. If the patient is on a heart lung machine, select Cardiac Bypass on the alarm menu.	- - -
Volume Apnea > 2 min	High	No mechanical breaths or spontaneous breaths >20 mL in last 120 seconds.	See above	- - -
Vt Compensation Off	Medium (low after acknowledge)	The system supplies the set breath but cannot adjust ventilation for compliance and resistance losses, etc.	Adjust VT manually and continue without compensation, or change to the pressure control mode. In pressure control set Pinspir	Replace the flow sensor module and select the mode again. If the problem stops, inspect the two flow sensors.
VT Not Achieved	Low	Tidal volume measured by inspiratory flow sensor < set value 6 breaths in a row after the first minute of mechanical ventilation.	Adjust controls to supply adequate tidal volumes. Check I:E; PLimit; and volume settings.	Possible leak.
Vte > Insp Vt	Low	Expired volume > inspired volume for 6 breaths with a circle module.	Check patient condition.	- - -

1. When power is first turned on.
2. Flow sensors are also used to measure pressures.
3. The sustained pressure threshold is calculated from the pressure limit setting. When mechanical ventilation is on, the sustained limit is calculated as follows: for pressure limits < 30 cm H_2O, the sustained pressure limit is 6 cm H_2O; for Plimit between 30 and 60 cm H_2O, the sustained limit is 20% of the pressure limit (Plimit); for pressure limits >60 cm H_2O, the sustained pressure limit is 12 cm H_2O. If both PEEP and Mechanical ventilation are on, the sustained pressure limit increases by PEEP - 2 cm H_2O (the compensated weight of the bellows). When mechanical ventilation is off, the sustained pressure limit is calculated as follows: for pressure limits ≤ 60 cm H_2O, the sustained pressure limit is 50% of the pressure limit (Plimit); for pressure limits >60 cm H_2O, the sustained pressure limit is 30 cm H_2O.

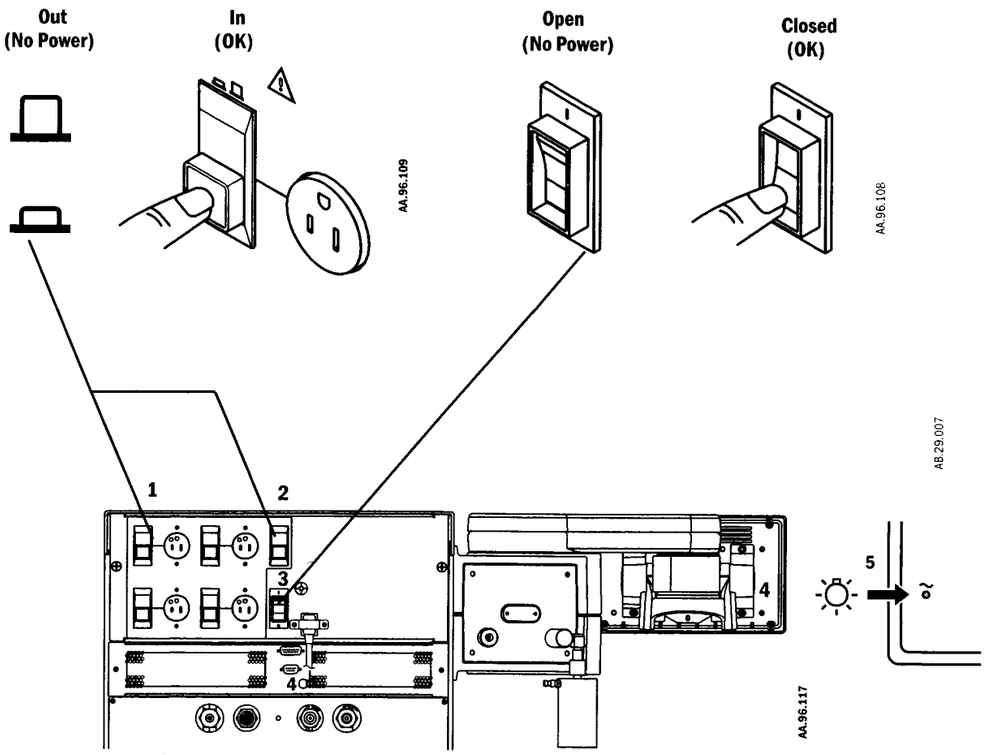
Breathing system problems (no alarm)

Symptom	Problem	Solution(s)
Gas scavenging flow is too low.	Suction supply problem.	Use a different suction supply.
	Filter blockage. Active systems have a flow indicator to show this.	Replace the filter. Refer to "Scavenging path disassembly" in Section2, Maintenance.
The bellows fills when the Bag/Vent switch is set to Bag or the bag fills when the switch is set to Vent.	Leak through Bag/Vent switch. Causes include dirt or damage to the o-ring.	Refer to "Main manifold, APL Valve, and Bag/Vent switch maintenance" in Section 2, Maintenance.
The ventilator does not read the position of the Bag/Vent switch. Use manual ventilation, if necessary.	Ventilator or absorber malfunction.	Ventilate manually. Ask a qualified service representative to repair the system.
The ventilator does not correctly identify the breathing circuit module.	Broken identification tabs.	Remove the module and look at the tabs on the rear. If there is damage, use a different module.
	Dirt on the optical sensors that read the tabs.	Use a DAMP alcohol prep to gently clean. Squeeze dry the prep before you use it.
	Ventilator malfunction.	Ask a qualified service representative to repair the system.
APL valve does not operate correctly.	APL valve problem	Replace APL Valve seal and diaphragm - Refer to User Maintenance

Electrical problems (power failure, etc.)

⚠**WARNING** If a circuit breaker opens frequently, do not use the system. Have an approved service representative repair the system

Symptom	Problem	Solution
Mains indicator is not ON.	The electrical power cable is not connected.	Connect the power cable.
	The inlet circuit breaker (toggle switch) is open.	Close the circuit breaker (Figure 5-1).
	The power cable is damaged.	Replace the power cable.
	The electrical socket the power cable connects to has no power.	Use a different electrical socket.
	An internal fuse is open.	Have a service representative repair the system.
The electrical outlets do not have power but the mains indicator is ON.	The main outlet circuit breaker is open.	Close the circuit breaker.
One electrical outlet does not have power.	The outlet circuit breaker is open.	Close the circuit breaker.
A circuit breaker opens frequently.	Equipment connected to the outlet(s) uses more current than the circuit breaker rating (Figure 6-1).	Use a different power supply for some of the equipment.
	The equipment connected to the outlet has a short.	Do not use the equipment until it is repaired.
Tec 6 has no power.	Not plugged into outlet.	Connect power cable.



1. Outlet CIrcuit Breakers*
2. Master Circuit Breaker-All Outlets*
3. Inlet Circuit Breaker*
4. Ventilator Fuse
5. Mains Indicator

* Labels shows ratings.

Figure 5-1 • Circuit breakers, fuse, and the mains indicator

Pneumatic problems

Symptom	Problem	Solution
High-pressure leak.	Controls are not set correctly.	Set the system switch to Standby and the auxiliary flowmeter to OFF.
	Equipment connected to pneumatic outlet.	Disconnect the equipment.
High-pressure leak.	Incorrect cylinder connection (cylinder yokes).	Make sure that there is only one cylinder gasket, the gasket is in good condition, and the T handle is tight.
	Incorrect cylinder connection (DIN connection.)	Make sure the nut is tight.
Low-pressure leak with a vaporizer ON.	The vaporizer is not correctly installed.	Correctly install the vaporizer.
	The vaporizer fill spout is loose (fill port type vaporizer).	Tighten the fill spout.
	Vaporizer port o-rings (external) are damaged or not installed.	Install new o-rings.
	A vaporizer malfunction (the leak stops if you use a different vaporizer in the same position).	Send the vaporizer to a Datex-Ohmeda Service Center.
	A port valve malfunction (the leak continues if you use a different vaporizer in the same manifold position).	Have an approved service person repair the vaporizer manifold.

⚠**CAUTION:** No repair should ever be attempted by anyone not having experience in the repair of devices of this nature.

Illustrated parts

In this section

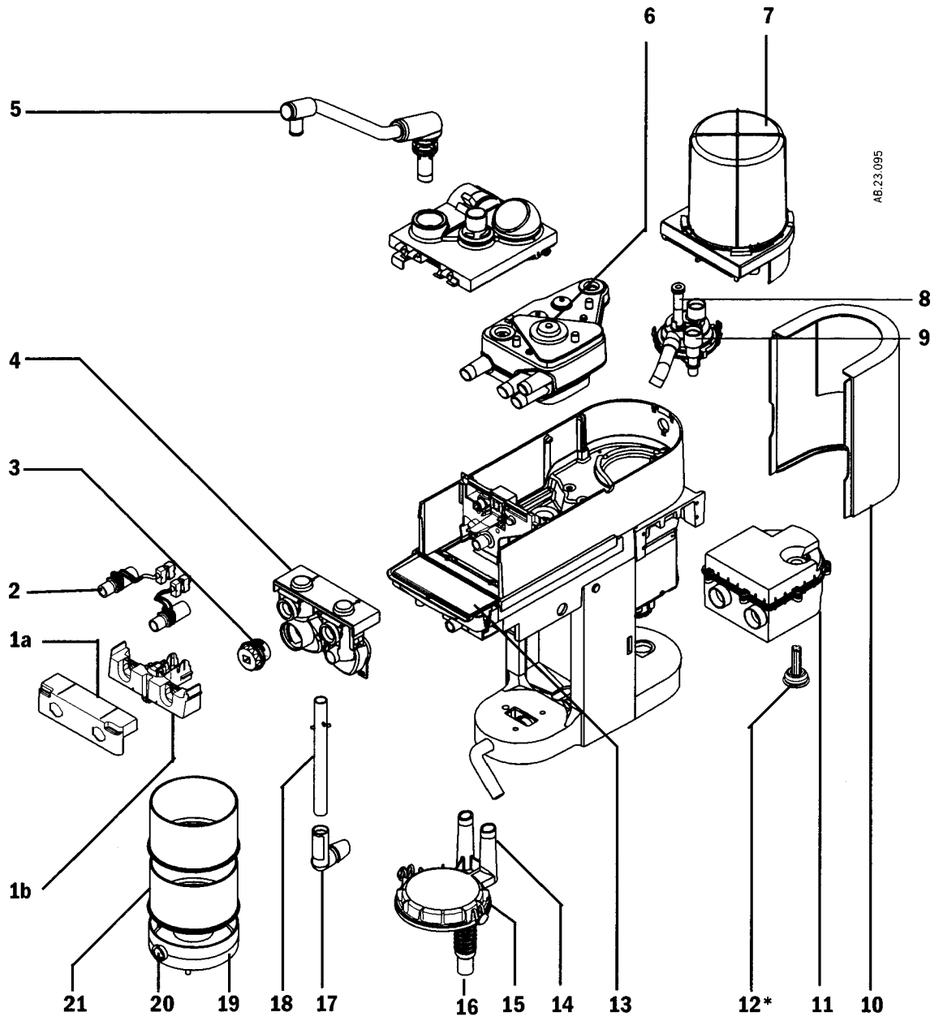
Breathing System Parts....6-2
Top level....6-2
Main manifold....6-5
Exhalation valve....6-7
Bellows....6-9
Test tools and system parts....6-10

Breathing system parts

Top level

Item	Description (Figure 6-1)	Stock Number
1	Flow sensor module (cover & holder)	1406-8208-000
a.	Cover only	1406-3401-000
b.	Holder only	1406-3400-000
2	Flow sensor (plastic)	1503-3220-000
	Flow sensor (metal - autoclavable)	1503-3244-000
3	O_2 sensor, cell	6050-0004-110
	O-ring	1406-3466-000
4	Breathing circuit module, circle	1406-8102-000
	Breathing circ. module, mapleson/Bain	1406-8211-000
	Breathing circuit module, open	1406-8212-000
5	Bag arm long (adjustable)	1406-3350-000
	Bag arm short (not adjustable)	1406-3380-000
6	Main manifold assembly	1406-8209-000
7	Autoclavable Bellows Assembly	1406-8105-000
8	Blank, pop-off valve	1406-3240-000
9	Exhalation valve assembly	1503-8114-000
10	Rear column cover	1406-3455-000
11	Gas scavenging (4 options)	--------
	Active gas scavenging assembly, 6.35 mm (ANSI, Not European Community)	1406-8216-000
	Active gas scavenging assembly, 30 mm threaded outlet	1406-8214-000
	Passive gas scavenging assembly, 30 mm ISO taper	1406-8215-000
	Passive gas scavenging assembly, 25 mm taper (DEU)	1406-8217-000
12	AGSS nylon filter, 225 µ,	1406-3521-000
13	Door Front, sensor	1406-3214-000

Item	Description (Figure 6-1)	Stock Number
14	Upper dish (2 options)	------
	Upper dish absorber plastic (seal not included)	1406-3413-000
	CO_2 bypass assembly metal (seal not included)	1406-3500-000
15	Upper seal	1406-3414-000
16	Tube corrugated 210 mm	1400-3009-000
17	Elbow transfer tube	1406-3576-000
18	Transfer tube	1406-3575-000
19	Drain dish assembly	1406-8218-000
20	Plug, sight glass-drain	0229-2080-100
	O-ring, plug	0210-0594-300
21	Canister	0229-3015-800
---	Not Shown	Stock Number
	Upper seal, upper dish, corr. tube, drain dish, canisters	1406-8207-000
	Barb cap, passive scavenging	1406-3542-000



* Active scavenging systems only

Figure 6-1 • Breathing system top assemblies

Main manifold

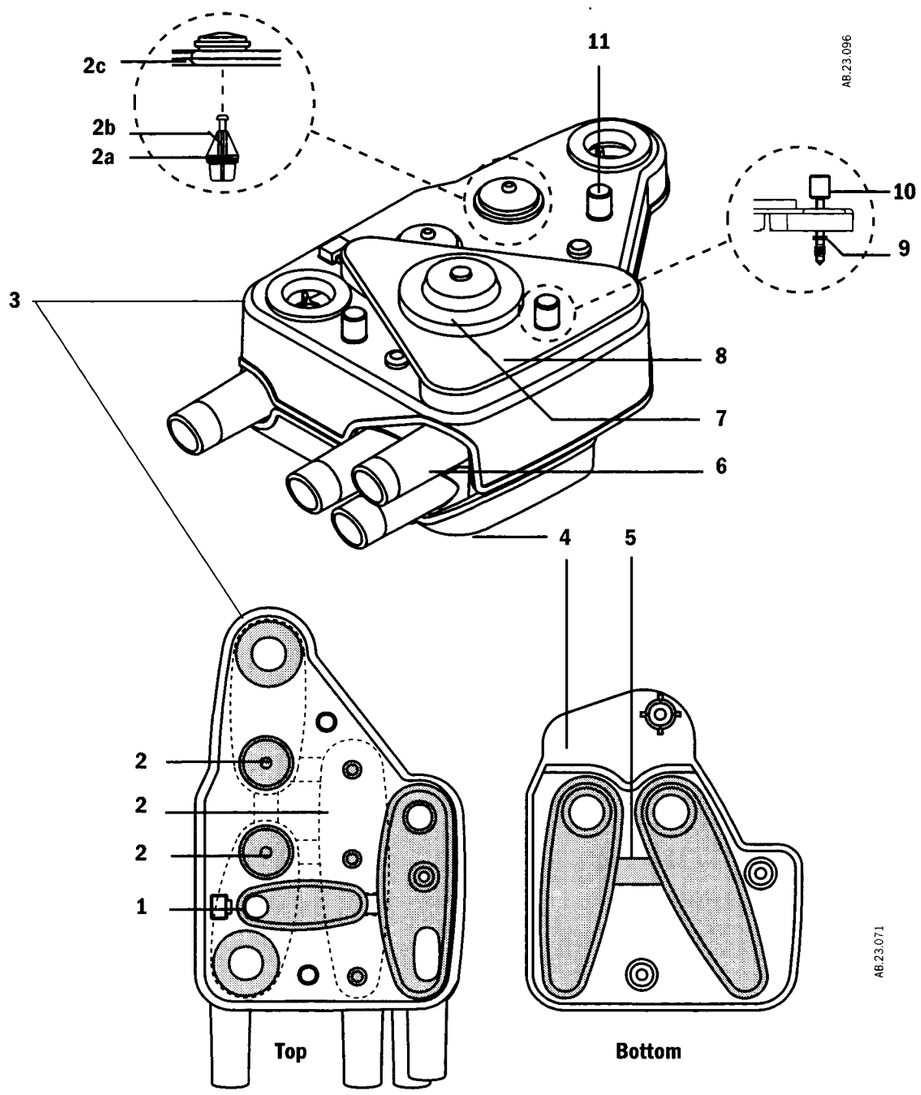


Figure 6-2 • Main manifold

Item	Description (Figure 6-2)	Stock Number
1	Seal, main manifold, APL/AGSS	1406-3316-000
2	Seal, bag/vent assy (a, b, c)	
	a.O-ring (Qty 2)	1406-3278-000
	b.Poppet (Qty 2)	1406-3279-000
	c. Seal only	1406-3314-000
3	Plate, top, main manifold	1406-3300-000
4	Plate, bottom main manifold	1406-3303-000
5	Seal, Main Manifold, Absorber	1406-3315-000
6	Body manifold, main	1406-3301-000
7	APL diaphragm assembly	1406-3331-000
8	Manifold APL/AGSS	1406-3302-000
9	Split ring (Qty 3)	1406-3319-000
10	M6x43 mm Thumbscrew	1406-3304-000
11	M6 x28.5 mm Thumbscrew (Qty 2)	1406-3305-000

Exhalation valve

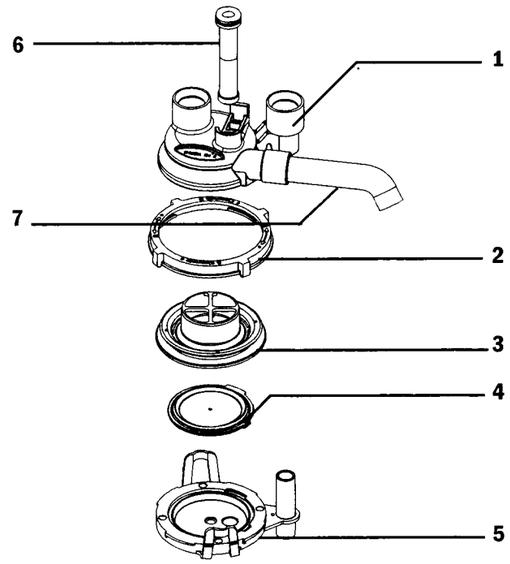


Figure 6-3 • Ventilator expiratory valve

	Description	Stock Number
1	Exhalation valve cover	1503-3583-000
2	Lock ring	1503-3588-000
3	Seat exhalation valve	1503-3584-000
4	Diaphragm assy	1503-8121-000
5	Base, exhalation valve	1503-3585-000
6	Blank, pop-off valve	1406-3240-000
7	Tube exhalation valve	1406-3566-000

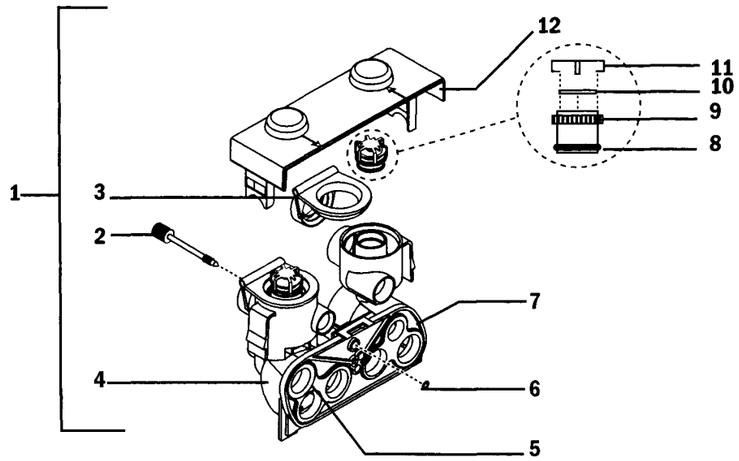


Figure 6-4 • Breathing circuit modules

	Description	Circle	Bain-Mapleson D	Open
1	Assy (items 2-12)	1406-8102-000	1406-8211-000	1406-8212-000
2	M6-1x23 Thumb Screw	1406-3304-000	1406-3304-000	1406-3304-000
3	Seal lens, flow sensor	1406-3395-000	1406-3395-000	1406-3395-000
4	Module Body	----------	1406-3467-000	1406-3480-000
5	Seal module cover	1406-3317-000	1406-3463-000	1406-3318-000
6	Split Ring	1406-3319-00	1406-3319-000	1406-3319-000
7	Back plate	1406-3391-000	1406-3391-000	1406-3391-000
8	O-Ring Check Valve	1406-3397-000	Not Used	1406-3397-000
9	Valve Seat Check Valve	1406-3396-000	Not Used	1406-3396-000
10	Disc Check Valve	0210-5297-100	Not Used	0210-5297-100
11	Retainer Check Valve	1400-3017-000	Not Used	1400-3017-000
12	Lens	1406-3394-000	1406-3461-000	1406-3394-000

Bellows

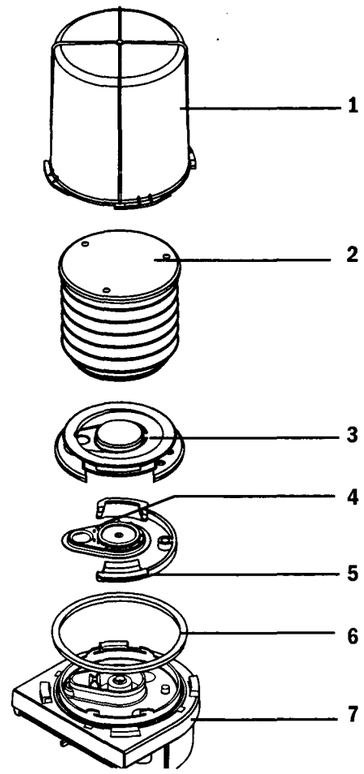


Figure 6-5 • Bellows parts

Item	Description	Stock Number
1	Bellows housing	1500-3117-000
2	Bellows	1500-3378-000
3	Rim	1500-3351-000
4	Pressure relief valve assy	1500-3377-000
5	Latch, base	1406-3318-000
6	Seal, base	1500-3359-000
7	Base, bellows	1406-3313-000

Test tools and system parts

Description	Stock Number
Vaporizer port o-rings, external (Qty 6)	1102-3016-000
Cylinder gasket	0210-5022-300
Handle for yoke tee	0219-3372-600
Yoke plug	0206-3040-542
Din O_2 plug (cylinder connection)	1202-7146-000
Positive-low -pressure leak test device (BSI)	1001-8975-000
Positive-low -pressure leak test device (ISO)	1001-8976-000
Negative- low-pressure leak test device	0309-1318-800
Test lung	0219-7210-300
Krytox	1001-3854-000
Touch-up paint, flint (medium) gray, 18 ml	1006-3851-000
Touch-up paint, quartz (light) gray, 18 ml	1006-3852-000
Touch-up paint, light aqua, 18 ml	1006-3853-000
Touch-up paint,Artic-white, 18 ml	1006-3363-000
Touch-up paint, Neutral Gray N7 (Medium Dark), 18 ml	1006-4198-000
Touch-up paint, Neutral Gray N8 (Medium), 18 ml	1006-4199-000
Touch-up paint, Neutral Gray N8 (Light), 18 ml	1006-4200-000
Bulb, 2.4 watts, gooseneck lamp	1006-3673-000
Gooseneck lamp assembly	1006-3026-000
Communication port cable	1105-0512-000

External Communications

In this section

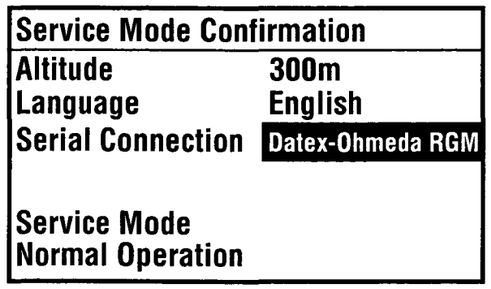
This section describes how to communicate between the ventilator and a data collection system or an external monitor. It also tells you what data can be sent and received.

External communications 7-2

Protocol Description (Datex-Ohmeda Com 1) 7-3

External communications

The ventilator has electrical interfaces (RS-232C) on each of two connectors. The 9-pin connector labeled port 1 is a proprietary channel and should only be used by qualified service personnel. The 15-pin connector labeled port 2 is a public channel. Always connect the cable from the monitor to the 15-pin connector (port 2).



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Protocol Selection	Application	Model /Version
Datex-Ohmeda RGM	Ohmeda RGM Resp. Gas. Monitor.	Version 3.0-5.1 (w/o gas comp data) Version 6.0 and later (includes gas composition data)
7800 Emulation	Monitors programmed to communicate with 7800	HP ACMS with compatible software. Use Datex-Ohmeda Cable 1503-3077-000
Datex-Ohmeda COM 1	HP ACMS Vue Link; monitors programmed for 7900 communication)	VueLink model M1032A with compatible driver and cable
Datex-Ohmeda COM 2	HP ACMS	HP ACMS with compatible software. Use Datex-Ohmeda Cable 1503-3077-000

Protocol Description (Datex-Ohmeda Com 1)

Electrical Interface

- RS-232C signal standards
- 15 pin female D connector (Port 2) - Data Communications Equipment configuration (DCE)

  pin 6 - receive data

  pin 13 - transmit data

  pin 5 - signal ground

Serial Communication Parameters

- Baud: 19.2K

Byte format: Start bit + 7 data bits + parity bit + stop bit

Parity: ODD

Software Interface Ohmeda Com 2.0 Waveform Communication Protocol

Command Headers:

<ESC>VTD	DISABLE CHECKSUM
<ESC>VTE	ENABLE CHECKSUM
<ESC>VTQ	ENABLE COMPRESSED MODE
<ESC>VTS	SLAVE MODE (RESETS AUTO MODE)
<ESC>VTX	AUTO MODE
<ESC>VT$	SEND SETUP DATA
<ESC>VT?	SEND ALL DATA
<ESC>VTW	ENABLE WAVEFORM DATA

Response Headers:

:VTD	MEASURED DATA RESPONSE
:VTM	SETUP DATA RESPONSE
:VTN	NACK (negative acknowledge)
:VTQ	STATUS DATA RESPONSE
:VTW	WAVEFORM DATA RESPONSE
:VTR	ALARM SILENCE SWITCH PRESSED RESPONSE
:VTY	ACK (positive acknowledge)

DEVICE COMMANDS Sent By External Device

Data Transmit Mode Select Commands

<ESC>VTXc<CR>Auto Mode

<ESC>VTSc<CR>Slave Mode

Data Format Mode Select Commands

<ESC>VTQc<CR>Compressed Format

Data Request Command

<ESC>VT?c<CR>Send All Data (Valid in Slave Mode only)

<ESC>VT$c<CR>Send Setup Data

Enable Waveform Data Mode

<ESC>VTWabc<CR>Send Waveform Data

<ESC>VTW<CR>=header

a & b = any one of the following:

(note 1: order determines order of data in response packet)

(note 2: b valid only if a != 0)

0	turn waveform data OFF
P	include Pressure Data
F	include Flow Data
V	include Volume
c	checksum
<CR>	terminator

Checksum Control Commands

<ESC>VTEc<CR>	Enable Checksum Mode
<ESC>VTDc<CR>	Disable Checksum Mode (checksum byte ignored in this command, but cannot be <CR>)

DEVICE RESPONSES Sent Back By Ventilator

ACK Response

:VTYc<CR>Positive Acknowledge Response

NAK Response

:VTNc<CR>Negative Acknowledge Response

Alarm Silence Switch Pressed Response

:VTRc<CR>Alarm Silence Switch Press Response (if no alarms are on or all displayed alarms are silenced)

Compressed-Data Measured Data Response

In auto mode, the Measured Data Response will be transmitted at the end of a breath or 10 seconds from the last transmission, whichever occurs first.

:VTDaaaabbbbdddeeefffggghhhiiijc<CR> Compressed Data Measured Data Response
(each entry is zero filled and right justified--i.e. aaaa = 0095)
"?" means bad data due to any technical problem(s);
"-" means data not available due to system state

aaaa	measured tidal volume	mL, ?, -
bbbb	measured minute volume	L*100,?, - ; example: 1000 equals 10.00 L
ddd	measured respiratory rate	/min,?, -
eee	measured oxygen level	% O_2,?, -
fff	measured max positive pressure	cm H_2O,?
ggg	measured inspiratory plateau pres	cm H_2O,?
hhh	measured mean pressure	cm H_2O,?
iii	minimum pressure	cm H_2O,?
j	measured data status	0100000x (bit 0=1=new breath data; bit 0=0=10 second data)
c	checksum	

Compressed-Data Status Data Response

The Status Data Response will be transmitted every 1 second (if a change occurs in the status data) or a minimum of once every 10 seconds. Note that the status byte bit is set=1 for an active condition and 0 for an inactive condition.

:VTQaaaabbbddddeeffgggghhiijjjkkkllllmmmnnnooooqrrrrrrrrrrc<CR>

Compressed Data Status Data Response

aaaa	set tidal volume	mL
bbb	set tidal volume	/min
dddd	set I:E ratio	1:eee.e
ee	inspiratory pause	% Pause
ff	set PEEP	cm H_2O
ggg	set peak pressure limit	cm H_2O
hh	set inspired pressure	cm H_2O
ii	set sustained pressure alarm limit	cm H_2O
jjj	high minute volume alarm limit	L*10 (e.g. 650 = 65.0 L)
kkk	low minute volume alarm limit	L*10 (e.g. 050 = 5.0 L)
lll	high Vte limit	mL/10 (e.g. 150 =1500 ml)
mmm	low Vte limit	mL/10 (e.g. 090 =900 ml)
nnn	high oxygen alarm limit	% O_2
ooo	low oxygen alarm limit	% O_2
q	ventilation mode: "v"=volume mode,'p'=pressure mode,'b'=Vt compensation off,'-'=bag mode only	
rrrrrrrrrrr	status bytes (see bitmaps below)	
c	checksum	

Status Bytes Bitmaps

The status bytes are a string of 12 bytes, starting from the left (Byte 1) to the right (Byte 12). Each Byte has eight bits of data from D7 (MSB) to D0 (LSB).

bit byte 1

Vent. Message
D0 - High O_2
D1 - Low O_2
D2 - 1
D3 - 1
D4 - 1
D5 - Check O_2 Sensor
D6 - O_2 Calibration Error

bit byte 2

Vent. Message
D0 - -High Paw
D1 - Low Paw
D2 - Sustained Paw (shutdown)
D3 - Sustained Paw
D4 - Sub-Atmos Paw
D5 - 1
D6 - 1

bit byte 3

Vent. Message
D0 - Pinspired Not Achieved
D1 - PEEP Not Achieved
D2 - No Pressure Mode/PEEP
D3 - Manifold Pressure Sensor Failure
D4 - Inspiratory Overshoot
D5 - Inspiration Stopped
D6 - High Pressure Limit Reached (min sys)

bit byte 4

Vent. Message
D0 - Low VE
D1 - High VE
D2 - Low Vte
D3 - High Vte
D4 - Vt Not Achieved
D5 - Volume Apnea
D6 - Volume Apnea > 2 min

bit byte 5

Vent. Message
D0 - No Insp Flow Sensor
D1 - No Exp Flow Sensor
D2 - Insp Reverse Flow
D3 - Exp Reverse Flow
D4 - Check Flow Sensors
D5 - Insp Vt/Vte Mismatch
D6 - Vdel Mismatch

bit byte 6

Vent. Message
D0 - Bellows Empty
D1 - Flow Valve Failure
D2 - Gas Inlet Valve Failure
D3 - 12 Hour Test
D4 - "Bootup GIV Failure"
D5 - No O_2 Pressure
D6 - No Fresh Gas Flow

bit byte 7

Vent. Message
D0 - +Vanalog Failure
D1 - -Vanalog Failure
D2 - +15V SIB Out-of-Range
D3 - +15V Manifold Out-of-Range
D4 - Display Voltage Out-of-Range
D5 - Vaux_ref Out-of-Range
D6 - Vext_ref Out-of-Range

bit byte 8

Vent. Message
D0 - A/D Converter Failure
D1 - CPU Failure
D2 - Memory (EEPROM) Failure
D3 - Memory (flash) Failure
D4 - Memory (RAM) Failure
D5 - Memory (video) Failure
D6 - Bootup Memory Failure

bit byte 9

Vent. Message
D0 - Software Watchdog Failure
D1 - Hardware Watchdog Failure
D2 - Internal Vent. Clock Too Fast
D3 - Internal Vent. Clock Too Slow
D4 - CPU Internal Error
D5 - Memory (redundant storage) Fail
D6 - Flow Sensor Cal Data Corrupt

bit byte 10

Vent. Message
D0 - On Battery
D1 - No Battery
D2 - Low Battery Charge
D3 - Low Battery
D4 - Low Battery (shutdown)
D5 - Fail Batt. Volt. Out Of Range
D6 - Batt. Curr. Out Of Range

bit byte 11

Vent. Message
D0 - Circuit Auxiliary
D1 - Auxiliary Breathing Circuit
D2 - "no confirmation of changed setting"
D3 - Control Settings Input Has Failed
D4 - Heliox Mode is ON
D5 - Volume Compensation Off
D6 - Mechanical Ventilation On

bit byte 12

Vent. Message
D0 - Volume Mode Active
D1 - Apnea Detect ON
D2 - Apnea Alarm Silenced
D3 - Very Low VE Limit
D4 - Alarms Silenced
D5 - 1
D6 - Sensor(s) Cal Due

Setup Data Response :VTMaaaabddeffghc<CR>Setup Data Response

aaaa	software revision number	0001-9999 = 0.01-99.99
b	language (see note)	0-8
dd	display contrast setting	1-10
e	alarm volume setting	1-5
ff	altitude setting	-4 to 36, in 100's of meters
g	drive gas	O = oxygen, A = air
h	ventilator model number	0 = 7800, 1 = 7810, 5 = 7850, 6 = 7900/ Aestiva
c	checksum	

note: language: 0=English; 1=Spanish; 2=German; 3=Kanji; 4=Dutch; 5=Swedish; 6=French; 7=Italian, 8=Danish

Waveform Data Response

If Waveform Data Mode is enabled, a Waveform Data Response will be transmitted every 240 ms. Up to 2 blocks of fifteen (15) data samples taken every 16 ms. will be sent with each message. Each data value is a 3-digit, zero filled, right justified ASCII Hex representation of a 12 bit binary value

:VTW[aaabbb...nnnooo][aaabbb...nnnooo]c<CR>
Waveform Data Response for each [max. of 2] waveform signal selected

aaa	1st 16 ms waveform sample (0 -> "000", 512 -> "200", 4095 -> "FFF")
bbb	2nd 16 ms waveform sample
...	
nnn	14th 16 ms waveform sample
ooo	15th 16 ms waveform sample

Waveform Data shall be scaled as follows:

Pressure
range: -20 - 120 cm H_2O
scale:

raw	scaled	xmit.
-20	0	"000"
0	512	"200"
120	3584	"E00"

Flow
range: -100 - +100 L/M
scale:

raw	scaled	xmit.
-100	512	"200"
0	2048	"800"
+100	3584	"E00"

Volume
range: 0 - 2 L
scale:

raw	scaled	xmit.
0	512	"200"
2	3584	"E00"

The Waveform Data will be sampled as follows:

Pressure

Samples will be every taken from the airway pressure sensor every 16 ms.

Flow

For each breathing system the samples will be every 16 ms. The flow may be sampled from the inspiratory flow sensor and/or the expiratory flow sensor, depending on the circuit type and the phase of the breath. The inspiratory flow sample will always be positive and the expiratory flow sample will always be negative.

Circle Breathing System

If inspiratory flow > threshold (start of inspiration)

If inspiratory flow is increasing

Use inspiratory flow 16 ms sample

Else if inspiratory flow is decreasing and expiratory flow > threshold

Use expiratory flow 16 ms sample

Else

Use inspiratory flow 16 ms sample

Else If expiratory flow > threshold (start of expiration)

Use expiratory flow 16 ms sample

Else

Use the 16 ms flow sample from the previously used flow sensor

Volume Circle Breathing System

Samples will be every 16 ms and will be based on integration of flow values. Inspiratory flow will increase volume, expiratory flow will reduce the volume. The volume will be reset to 0 at the start of a inspiration.

Specifications and Theory of operation

In this section

Ventilation Theory 8-2
Pneumatic circuits 8-7
Suction regulators 8-10
O_2 Flow meter 8-10
Breathing system specifications 8-11
Pneumatic specifications 8-15
Flow specifications 8-16
Electrical Power 8-17
Electromagnetic compatibility 8-18
Physical Specifications 8-19
Environmental requirements 8-20
Ventilation Operating Specifications 8-21
Aestiva Ventilator Accuracy Data 8-23

Ventilator Theory

General

The ventilator pneumatics are at the rear of the breathing system.

A precision valve controls gas flow to the patient.

During inspiration, this gas flow closes the exhalation valve and pushes the bellows down.

During expiration, a small flow pressurizes the exhalation diaphragm to supply PEEP pressure.

Volume and pressure measurements come from flow sensors in the flow sensor module. Two tubes from each sensor connect to a transducer that measures the pressure change across the sensor, which changes with the flow. A third transducer measures airway pressures at the inspiratory flow sensor.

With circle and open circuit modules, volume monitoring uses the right (expiratory) flow sensor. The ventilator uses the other sensor to adjust its output for changes in fresh gas flow, small leaks, and gas compression upstream of the breathing circuit. There is no adjustment for compression in the patient circuit. If necessary, add the compression loss to the tidal volume setting (volume control mode). The average volume changes from compression in the breathing circuit is small (0.5 to 1.25 mL/cm H_2O).

For better precision:

- When the fresh gas mixture includes Heliox, use the Heliox mode (Ventilation setup menu). Heliox, used on some ANSI Models of the Aestiva, changes the data collected by the flow sensors. When Heliox mode is selected, the ventilator adjusts the flow sensor data to correct for these changes.
- A small quantity of gas bleeds through a resistor to help keep the pressure on the exhalation valve constant. At high airway pressures, this can cause a slight hiss during inspiration.

⚠WARNING Do not try to silence the pneumatic resistor. If it is blocked, the ventilator can malfunction and cause patient injury.

Always connect the expiratory flow sensor. If it is not connected, the patient disconnect alarm can not operate correctly.

Modes

The system has two modes of mechanical ventilation:

- *Volume control mode*
- Pressure control mode

Use the main menu to set the mode.

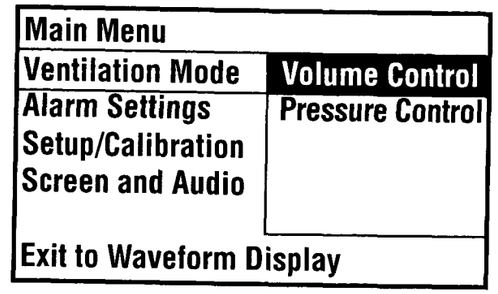


Figure 8-1 • Ventilation Setup Menu

Volume control mode

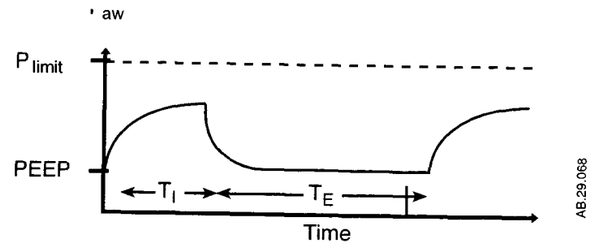


Figure 8-2 • Volume control diagram

Typically a volume control mode waveform shows increasing pressure during inspiration. Volume control supplies the set tidal volume during inspiration. The ventilator calculates a set flow and the length of the inspiratory period from the I:E and frequency settings. An optional inspiratory pause can be set to improve gas distribution in the lungs.

Volume control mode settings

- V_T(tidal volume),
- Rate,
- I:E,
- Plimit
- PEEP

Pressure control mode

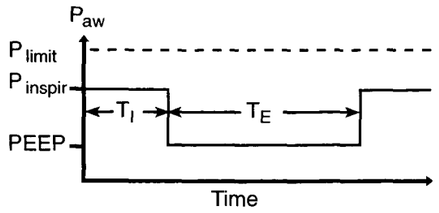


Figure 8-3 • Pressure control diagram

- Pressure control supplies a constant set pressure during inspiration. The ventilator calculates the inspiratory time from the frequency and I:E ratio settings. A high initial flow pressurizes the circuit to the set inspiratory pressure. The flow then decreases to maintain the set pressure (Pinspired).
- Pressure sensors in the ventilator measure patient airway pressure in the inspiratory limb and manifold pressure in the ventilator. These pressures permit the ventilator to adjust the flow to get set inspiratory pressure.

Pressure control mode settings

Pinsp (control pressure),
Rate,
I:E,
Plimit (pressure limit), and
PEEP.

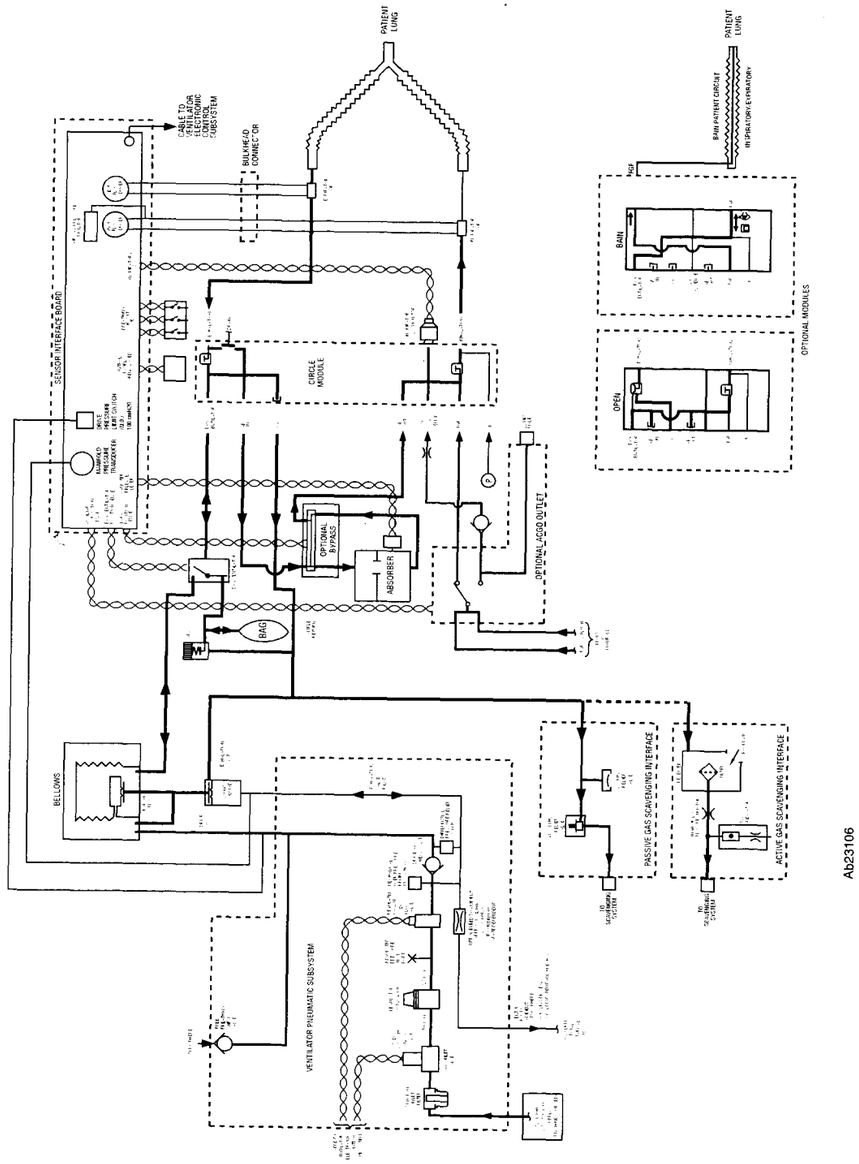
VT Comp Off

During some malfunctions, the ventilator automatically changes modes. Volume Compensation OFF supplies the set tidal volume. It cannot adjust the output to supply the set breath.

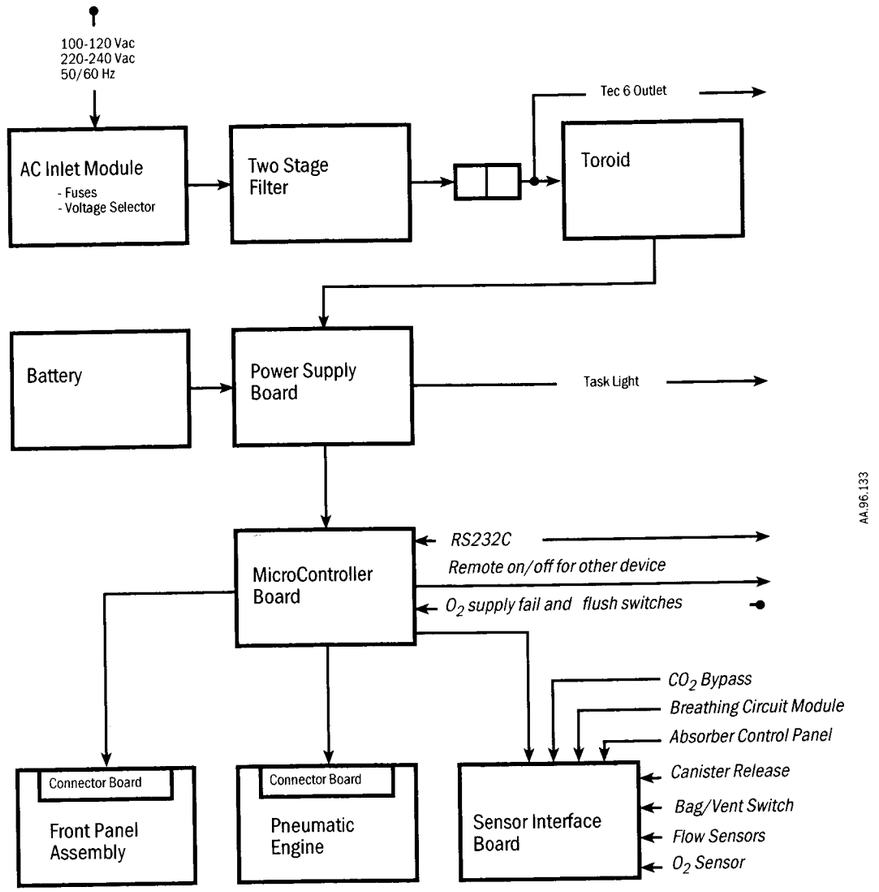
Minimum Monitoring

- Shows data
- No mechanical ventilation.
- "Monitoring Only" alarm message
- "Minimum System Failure" and specific failure message
- The software goes to minimum monitoring when a non-recoverable error occurs in boot-up or normal operations.

Breathing system schematic



Internal signal schematic



Pneumatic circuits

Gas supplies (items 1-6)

Gas goes into the system through a pipeline or cylinder connection. All connections have indexed fittings, filters, and check (one way) valves. Gauges show the cylinder and pipeline pressures.

A regulator decreases the cylinder pressures to the appropriate system pressure. A pressure relief valve helps protect the system from high pressures.

To help prevent problems with the gas supplies, install yoke plugs on all empty cylinder connections.

⚠ WARNING Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

O_2 flow (items7-14, 27)

Pipeline or regulated cylinder pressure supplies O_2 directly to the pneumatic outlet and the ventilator (O_2 ventilators). A second regulator decreases the pressure for the flush valve and the auxiliary flowmeter.

The flush valve supplies high flows of O_2 to the fresh gas outlet when you push the flush button. The flush switch uses pressure changes to monitor the position of the flush valve. A message on the ventilator tells you when Flush is ON.

When the system switch is ON, O_2 flows to the rest of the system and there is a minimum flow of 25 to 75 mL/min through the O_2 flowmeter.

A secondary regulator supplies a constant O_2 pressure to the flow meter.

An electrical switch monitors the O_2 supply pressure. If the pressure is too low, an alarm appears on the ventilator.

Air, N_2O, and third gas flow (items 7, 8, and 15-23)

Balance regulators control the flow of N_2O and the optional gas (CO_2, Heliox) to the flow control valves. Oxygen pressure at a control port adjusts the output of the regulator. This stops flow during an O_2 supply failure and makes sure that the hypoxic gas pressures increase and decrease with the O_2 supply pressure.

A chain linkage on the N_2O and O_2 flow controls helps keep the O_2 concentration higher than 20% (approximate value) at the fresh gas outlet.

Pipeline or regulated cylinder pressure directly supply Air to the ventilator (Air Ventilators). When the system switch is ON, air flows to the rest of the system. A secondary regulator supplies the air flow control valve. Because there is no balance regulator, air flow continues at the set rate during an O_2 supply failure.

Mixed gas (item 26)

The mixed gas goes from the flowmeter outlet through the vaporizer that is ON, to the fresh gas outlet, and into the breathing system. A pressure relief valve sets the maximum outlet pressure.

Key to Numbered Components

1. Pipeline pressure gauge
2. Pipeline connection
3. Cylinder pressure gauge
4. Cylinder connection
5. Cylinder pressure regulator
6. Pressure relief (opens at approx. 918 kPa)
7. Supply connections for the ventilator
8. System switch
9. Alarm for low O_2 supply pressure
10. Secondary O_2 regulator
11. O_2 flow control valve
12. O_2 flow tube
13. Flush regulator
14. O_2 Flush
    a. Flush valve
    b. Switch (used with the ventilator)
15. N_2O balance regulator
16. N_2O flow control valve
17. N_2O flow tube
18. Air secondary regulator
19. Air flow control valve
20. Air flow tube
21. Optional gas balance regulator
22. Optional gas flow control valve
23. Optional gas flow tube
24. Vaporizer port valve
25. Vaporizer
26. Pressure relief (opens at approx. 38 kPa)
27. Aux. flowmeter (optional)

Key to Symbols

- Pneumatic Connection
- Filter
- Direction of Flow
- Check Valve (approx. 10 L/min reverse flow -STP)

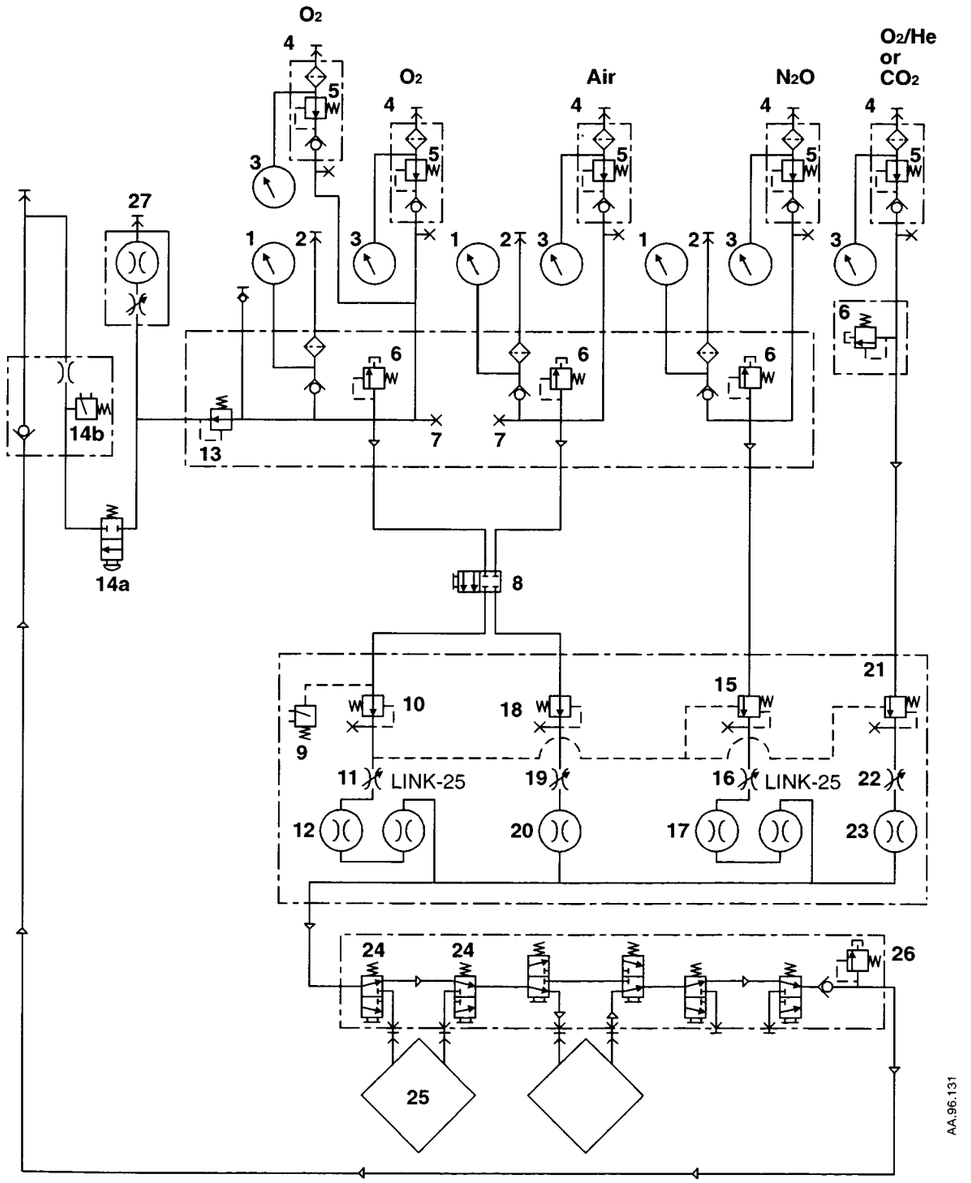


Figure 8-4 • Pneumatic circuit

Suction regulators (optional)

Venturi Suction Regulator

Supply: air or O2 from system gas supply.

Drive gas consumption: 75 L/min

Maximum Vacuum: 457 mm Hg with pipeline drive gas at 345 kPa.

Minimum flow: 20 L/min

Sound level 53 dBA

Accuracy: 5% of full scale

Continuous Suction Regulator

Supply: External vacuum

Vacuum levels: 0-200 mm Hg and full line vacuum

Maximum flow: >20 L/min

Accuracy: 5% of full scale

O_2 flow meter (optional)

Supply: O_2 from system gas supply.

flow rates: 0-10 L/min

Accuracy: 5% of full scale

Breathing system

There are three types of breathing circuit modules (Figure 8-5):

1. Circle
2. Mapleson D/Bain(With Mapleson D/Bain circuits one flow sensor measures Inspiratory and expiratory flows. The other measures fresh gas.
3. Open

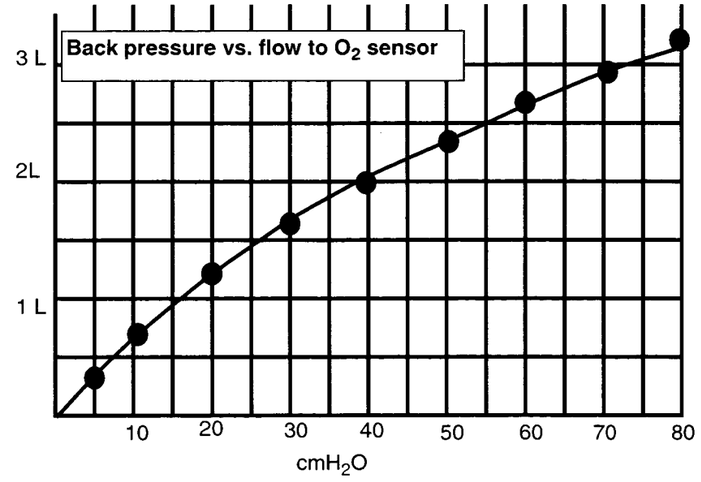
Tabs on the circuit modules fit into infra -red switches on the breathing system bulkhead. The ventilator uses these switches to identify the circuit module.

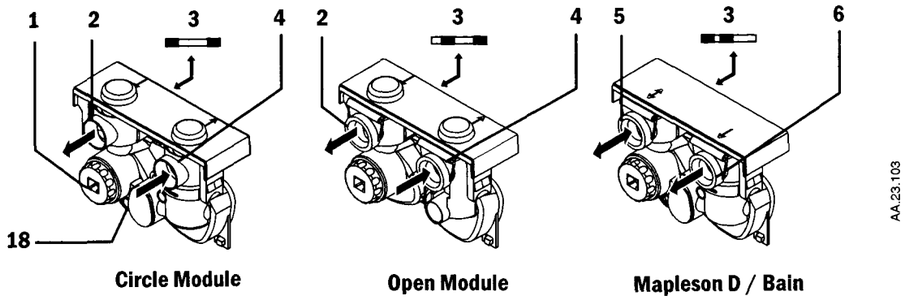
Module	Patient Circuit Connections	One-Way Valves
Circle	Left: inspiratory Right: expiratory	Inspir. & expir. check valves
Mapleson D/ Bain	Left: to-fro Right: fresh gas	None
Open	Left: inspiratory Right: expiratory	Inspir. check valve. Pressure controlled expiratory valve.

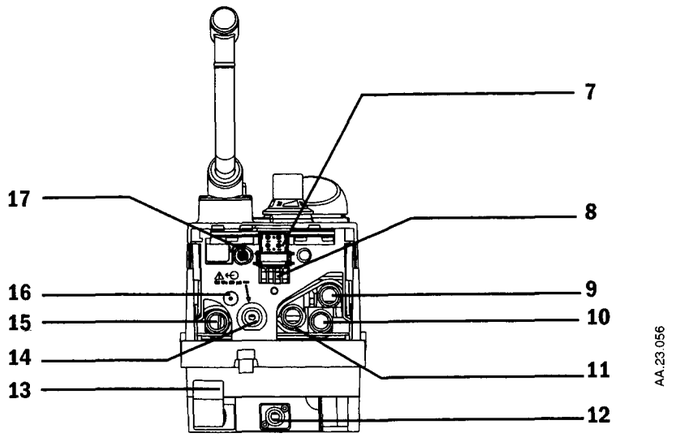
Direct fresh gas connections (common and auxiliary outlets)

When you make a direct connection to one of these outlets:

- Mechanical ventilation is not available
- The pressure gauge, Bag/Vent switch, APL valve, and bag arm are not part of the circuit.
- Volume and pressure monitoring are not available.
- Flow from the auxiliary outlet to the O_2 sensor is:







1. O_2 Sensor (ventilator) Or Plug
2. Inspiratory Port
3. Tabs (Identify the Breathing Circuit Module to ventilator)
4. Expiratory Port
5. To-Fro Port
6. Fresh Gas Port
7. Flow Sensor Module Connector (Used with ventilator)
8. Optical Switches (Use Tabs To Identify Circuit Module)
9. Internal Connection (To Gas Scavenging System - Open Module Only)
10. Internal Connection (Exhaled gas flows to absorber during expiration)
11. Internal Connection (To Bag/Vent Switch)
12. Auxiliary Common Gas Outlet (Some Models)
13. Selector Switch (Auxiliary Common Gas Outlet)
14. Common Gas Outlet
15. Internal Connection (Mixed gas from absorber during inspiration)
16. Internal Connection (Aux. Com. Gas Outlet To O_2 Sensor)
17. Pressure Gauge Tap
18. Drain Valve (Push In To Drain water into the Drain Dish At Bottom Of Absorber)

Note: Items 12 and 14 are both called fresh gas outlets.

Figure 8-5 • Breathing circuit modules and connections

Breathing system specifications

Volume: 5500 ml

Absorbent: 1.35 kg (400 ml) / canister

Connections:

Breathing circuit modules: Circle, open, or Bain modules

Common gas outlet: ISO 5356 type connector (Standard 22 mm OD or 15 mm ID conical friction fit connectors). Remove the breathing circuit module to access.

Auxiliary outlet: ISO 5356 type connector on the front of the breathing system (Standard 22 mm OD or 15 mm ID conical friction fit connectors) (Optional).

System leakage:

These values are for continuous pressure and are higher than those expected during mechanical ventilation.

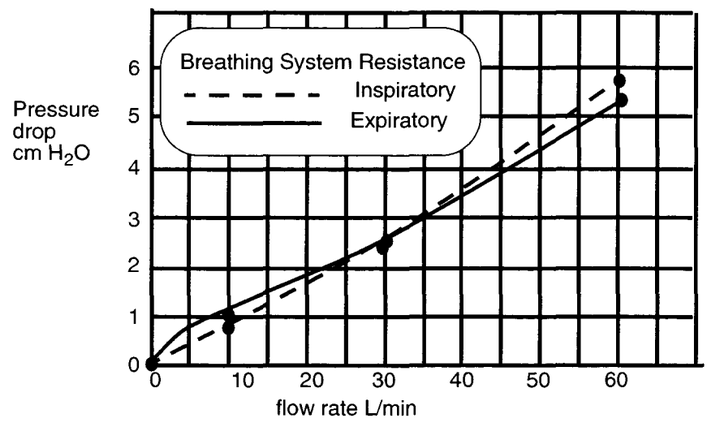
≤ 300mL/min total at 3 kPa; ≤75 ml/min for all connectors and two part tubes and ≤ 225 mL/min for all other breathing system assemblies.

System compliance

Volume of gas lost due to internal compliance (bag mode only) 5.15 mL/cm H_2O

Breathing system resistance

Y piece or T piece adds ≤0.15 kPa expiratory resistance at 1 L/sec.



Pressure required to open inspiratory and expiratory valves:

Dry: 0.49 cm H_2O
Moist: 0.91 cm H_2O

Breathing system leakage (average during use)

Pressure	Bag Mode (ml/min)	Vent Mode (ml/min)
30 cm H_2O	0.089	0.063
60 cm H_2O	N/A	0.106
90 cm H_2O	N/A	0.163

APL Valve:

Approximately 0 to 70 cm H_2O

Pressure Flow Data (APL Valve Completely Open)

Flow (L/min)	Flow (L/sec)	APL Pressure cm H_2O
3	0.05	1.12
10	0.17	1.26
20	0.34	1.77
30	0.51	2.36
40	0.68	3.14
50	0.83	4.06
60	1.0	5.14

System volume: 5500 mL

Gas scavenging

Passive scavenging:

Positive pressure relief: 10 cm H_2O.

Negative pressure relief: 0.5 cm H_2O.

Outlet connector: 30 mm male taper swivel.

Active scavenging:

Particle filter at the outlet has a pore size of 225 microns. All flow data uses a new filter.

Disposal System Type	Outlet Swivel Connector *	Flow Range	Pressure
Low flow, high vacuum	DISS EVAC	36 ±4 SLPM at 300 mmHg (12 inHg)	300 mmHg (12 inHg) Minimum vacuum
High flow	BS6834	50 - 80 SLPM	1.6 kPa at 75 SLPM
Venturi/Ejector	½ in. hose barb	30 - 100 SLPM	n/a

* Other market-specific connectors may be available.

Pneumatic specifications

Gas supplies: Pipeline gases: O_2, Air, N_2O

Cylinder gases: CO_2, Heliox, O_2, N_2O, Air (maximum: 2 cylinders of each gas; 4 cylinders total on narrow models; 5 cylinders total on the wide model.

Cylinder connections: Pin indexed (all gases); nut and gland DIN 477 (O_2, N_2O, Air); large cylinder kit available for O_2 and N_2O.

Primary regulator output pressure:

- With a rear panel label:

The primary regulator is set to pressure less than 345 kPa.

The primary regulator is set to pressure less than 414 kPa.

- Without a rear panel label : approximately 587- 690 kPa

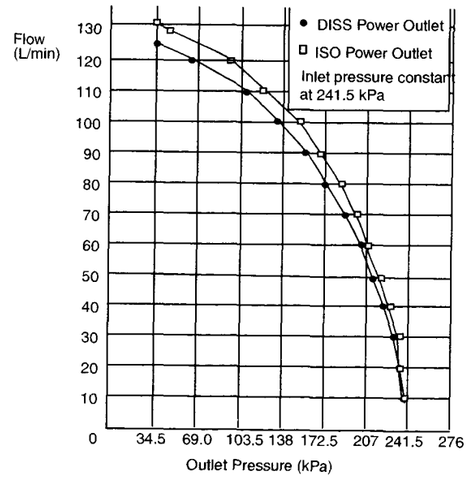
Pressure relief valve : approximately 883 kPa.

Pipeline connections (filtered): DISS-Male; DISS-Female; DIN 13252; AS 4059 (Australian); F90-116 (French Air Liquide); CEN (QPREN 737-6); or NIST (ISO 5359). All fittings available for O_2, Air, and N_2O.

Pressure displays: Color coded gauges

Pneumatic outlet

O_2 DISS or Mini schraeder connections



Common gas outlet relief: Valve limits fresh gas to 138 kPa at the flush flow.

Flow specifications

Flow rates

Minimum O_2 flow: 25 to 75 mL/min

Gas	Flow Range	Scale (One Flow Tube)	Scale (Two Flow Tubes)
O_2	0.05-15 L/min	----------	0.05 -0.95 L/min 1-15 L/min
N_2O	0-10 L/min[1]	----------	0.05 -0.95 L/min 1-10 L/min
Air	0-15 L/min	1-15 L/min	0.05 -0.95 L/min 1-15 L/min
He	0-15 L/min	0.5-15 L/min	----------
CO_2	0-0.5 L/min	0.05-0.5 L/min	----------

1. The link system sets the nominal O2 flow at 25% of the total O2 and N2O flow.

Accuracy

At 20°C with gas supply pressures at 345 kPa and an outlet pressure of 101.3 kPa (absolute) flowmeter accuracy agrees with VDE 3513 Part 3, Accuracy Class 2.5 or better.

Different breathing circuit pressures, barometric pressures or temperatures change the accuracy. With some conditions, these changes can be larger than the tolerances.

Flush flow

35-50 L/min

O_2 supply failure alarm and shutoff

	O_2 Pressure
O_2 supply failure alarm	193 to 221 kPa
N_2O shutoff	3.5 kPa
CO_2 or Heliox shutoff	69 kPa

Electrical power

Supply voltage

100-120 or 220-240 Vac ± 10% at 50 or 60 Hz

Electrical circuit breakers

Inlet Circuit Breakers

	100-120 Vac	220-240 Vac
No outlets	5A	3A
With Outlets	10A	6A

Master Circuit Breaker-All Outlets

100-120 Vac	220-240 Vac
5A	3A

Outlet Circuit Breakers

	100-120 Vac	220-240 Vac
No outlets	(3) 2A (1) 3A	(3) 1A (1) 2A

Circuit Breaker for Tec 6 Outlet (limited by master circuit breaker)

System leakage current limit - do not exceed

UL and CSA rated systems (USA and Canada) <300 µamps for the system and all systems connected to electrical outlets.

IEC rated systems (Not USA and Canada) <500 µamps for the system and all systems connected to electrical outlets

Note: Products connected to the electrical outlets may increase the leakage current above these limits.

Resistance to ground:

<0.2 Ω

Power cord

Length	5 meters
Voltage rating	125 to 264V ac at 10A, by country and/or translation
Current Carrying Capacity	10A
Type	Three conductor medical grade power supply cord by country and/or translation

Electrical Fuses

T6.3L/250V.

Battery Information

A sealed lead acid battery supplies battery backup for the Aestiva. The Aestiva is not a portable unit. Batteries are used as back up power in case of a power failure. Thus the battery is in a float charge state most of the time. Batteries meet the following:

1. Capacity to operate for 30 minutes.
2. Unit functions to specifications through the transition to battery power.
3. Long float charge life.
4. Battery pack is internally fused - in line replaceable
5. Battery terminals and connecting wires are protected against short circuits.

Only Datex-Ohmeda service representatives are to replace the battery. Batteries must be disposed of in accordance with applicable regulatory requirements in effect at the time and place of disposal.

Electro-magnetic Compatibility

Environment: Suitable for use in the EM environment described in EN 60601-1-2

Immunity Levels: The Aestiva complies with the requirements of EN 60601-1-2 (Electromagnetic Compatibility - Requirements and tests). The following basic EMC standards were applied to verify conformance.

Emissions CISPR 11 Group 1 (EN 55011)

Immunity IEC 801-2, 8 kV air, 3 kV contact
IEC 801-3, 3 V/m
IEC 801-4, 2 kV power line
IEC 801-5, 2 kV line to earth, 1 kV line to line

Physical specifications

All specifications are approximate values and can change without notice.

Weight:
2 vaporizer system: 136 kg
3 vaporizer system: 154 kg

Dimensions:

2 vaporizer system
Height: 135.8 cm
Width: 75.0 cm
Depth: 83.0 cm
Shelves:
Number: 0, 1, or 2
Size: 47.5 x 35 cm or 67.5 x 35 cm
Usable height (2 shelves)[1]: 26 or 36 cm
Weight Limit: 23 kg per shelf

3 vaporizer system
Height: 135.8 cm
Width: 93.0 cm
Depth: 83.0 cm
Shelves:
Number: 0, 1, or 2
Size bottom shelf: 87.5 x 35 cm or 67.5 x 35 cm
Size top shelf: 47.5 x 35 cm or 67.5 x 35 cm
Usable height (2 shelves)[2]: 26 or 36 cm
Weight Limit: 23 kg per shelf

Casters: 12.5 cm with brakes on the front casters.

Drawers: Optional: 14.5 x 38.5 x 26.0 cm
Standard drawer: 10.5 x 38.5 x 26 cm

Ventilator display: 7.6 x 15.2 cm

1. Flat or 10° angle shelves have the same usable height.
2. Flat or 10° angle shelves have the same usable height.

Environmental requirements

Temperature

Operation	10 to 40 °C, (Oxygen cell operates to specifications at 10 to 40 °C)
Storage	-20 to 70 °C Oxygen cell storage is -5 to 50°C, 10 to 95% Rh, 500 to 800 mm Hg

Humidity

Operation	15 to 95% Rh, non-condensing
Storage	10 to 100% Rh, include condensing

Altitude

Operation	500 to 800 mm Hg (3565 to -440 meters)
Storage	375 to 800 mm Hg (5860 to -440 meters)
Compensation range	525 to 795 mmHg (3,000 to -100 meters)

Ventilation Operating Specifications

Pneumatics

Gas Source	Anesthesia System
Gas Composition	Medical Air or O_2
Nominal Supply Pressure	350 kPa
Pressure Range at Inlet	240 to 700 kPa
Peak Gas Flow	120 L/m @ 240 kPa, 0.75 seconds
Continuous Gas Flow	80 L/m @ 240 kPa
Flow valve range	1 to 120 L/min at 240kPa.

Fresh gas compensation

Flow Compensation Range	200 mL/min. to 15 L/min.
Gas Composition	O_2, N_2O, N_2 Air, Heliox, CO_2 Anesthetic Agents

Pressure

Patient airway pressure range	-20 to +120 cm H_2O +/-2 cm H_2O
High pressure alarm set range	12 to 100 cm H_2O, 1 cm increment
Sustained pressure alarm range	6 to 30 cm H_2O, 1 cm increment
Display range	-20 to 120 cm H_2O

Volume

Tidal volume display range	0 to 9999 mL, 1 mL resolution
Setting range	20 to 1500 mL
Minute volume	0.0 to 99.9 liters, 0.1 liter resolution
Breath rate	4 to 100 bpm (breaths per minute), 1 bpm resolution
Volume sensor type	Variable flow orifice

Oxygen

Display range	0 to 110% O_2
Display resolution	1% increments
Sensor type	Galvanic fuel cell
Measurement range	0 to 100% O_2
Measurement accuracy	Better than ± 3% of full scale
Cell response time	35 seconds[1]
Low O_2 alarm range	21% to 100%
High O_2 alarm setting	21% to 100% **Note:** Low O_2 limit may not be set above the high O_2 limit, nor may the high O_2 limit be set below the low O_2 limit.
Expected cell life	Four months of shelf life (23 °C room air) and one year of normal operation.

1. Response time of cell and adapter as measured using the test method described in ISO 7767 (1988-12-15), clause 50.9

Aestiva Ventilator Accuracy Data

The following accuracy data are based on patient conditions and settings described in ASTM F1101. The ventilator is assumed to be operating in volume mode (Heliox OFF). For the following to be true, the ventilator is operating with 100 percent oxygen in the breathing system; or, it is connected to an anesthesia gas analyzer. If the ventilator is operating without being connected to an anesthesia gas analyzer, additional errors are described in the gas composition charts that follow.

Volume Mode (100%O_2)

Volume delivery accuracy:	> 210 mL tidal volume - accuracy better than 7%
	< 210 mL tidal volume - accuracy better than 15 mL
	< 60 mL tidal volume - accuracy better than 10 mL
Volume monitoring accuracy	> 210 mL tidal volume - accuracy better than 9%
	< 210 mL tidal volume - accuracy better than 18 mL
	< 60 mL tidal volume - accuracy better than 10 mL

Pressure Mode (100% O_2)

Inspiratory pressure delivery accuracy	greater of ± 10% or ± 3 cm H_2O
PEEP delivery accuracy	± 1.5 cm H_2O
Pressure monitoring accuracy	greater of± 5% or ± 2 cm H_2O
Volume monitoring accuracy	> 210 mL tidal volume - accuracy better than 9%
	< 210 mL tidal volume - accuracy better than 18 mL
	< 60 mL tidal volume - accuracy better than 10 mL

Note: Gas composition errors may be in addition to the above normalized accuracy. When adding errors, positive errors can have the effect of nulling out negative errors.

Note: Use of anesthetic agent could affect the errors by approximately -0.95%/% volume agent in normal mode and roughly -2.5%/% volume agent in Heliox mode. If the ventilator is connected to an Ohmeda RGM (Respiratory Gas Monitor), the affect of gas composition on volume data is corrected for automatically.

Volume Compensation Off

Delivered volume accuracy: greater of ± 10% or ± 20 mL

(Open loop volume mode is not a normal user selectable ventilation mode. It is an uncompensated ventilation mode used when a possible inspiratory flow sensor problem has been detected. The delivery accuracy is evaluated at the ventilator drive gas outlet in this mode of operation.)

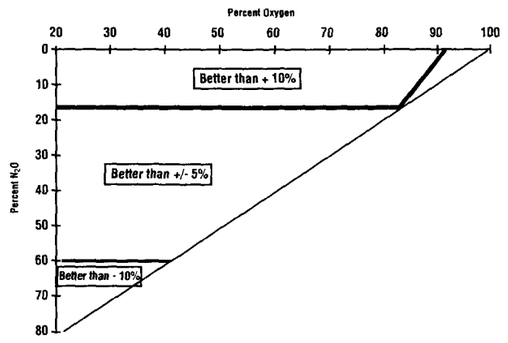


Figure 8-6 • Gas Composition Related Errors (Both Modes)

Heliox Mode

The effect on volume delivery and monitoring accuracies of Heliox mixtures is within +8% to -15% when operating the Aestiva Ventilator in the Heliox Mode.

Open loop mode volume delivery accuracy: +/- 10% of the set value under the following conditions:

1. Accuracy evaluated at the ventilator outlet.
2. This is not a normal operating mode. The ventilator is operating in an irregular condition.

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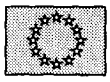

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Aestiva
O & M Manual, English
1006 0402 000
09 00 F 18 05 02
Printed in USA

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DESIGN AWARD WINNER 1998
INDUSTRIE FORUM DESIGN HANNOVER